Vol. 15 No. 4 OCTOBER, 1961

BRITISH JOURNAL OF PREVENTIVE & SOCIAL MEDICINE

P.H.

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LONDON
BRITISH MEDICAL ASSOCIATION
TAVISTOCK SQUARE, W.C.1

YEARLY SUBSCRIPTION (4 NUMBERS) £3 U.S.A. $10.00 SINGLE NUMBER 17s. 6d.

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Brit. J. prev. soc. Med. (1961), **15**, 143

CORONARY HEART DISEASE IN LONDON BUSMEN

A PROGRESS REPORT WITH PARTICULAR REFERENCE TO PHYSIQUE

BY

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The incidence of coronary heart disease (CHD) is less in the middle-aged conductors of London's double-decker buses than in the drivers of the same age. In particular, the "sudden death" rate of conductors under 50 is one-third that of drivers (Morris, Heady, Raffle, Roberts, and Parks, 1953; Morris and Raffle, 1954). By using information on sizes of uniforms, Morris, Heady, and Raffle (1956) showed also that the girth of conductors was less than that of drivers in each 5-year age group from 25–29 to 60–64.

This paper brings the evidence up to date and presents new information. Data about the rate of occurrence of all *first clinical attacks* in the two occupations are presented for 4 years, and about sudden deaths for 10 years, 1949–58.

The information about the size of uniforms covers a larger sample of garages and also compares drivers who had first been conductors with those recruited directly to driving. Direct physical measurements of waist, chest, and skinfold thickness made on samples of working busmen confirm the findings based on uniform size.

Having thus established occupational differences in disease and in physique, evidence is given of the relationship of disease to occupation and physique together. Comparison in terms of direct physical measurements is made between working, and therefore presumably healthy, men on the one hand and men with coronary heart disease on the other, for both conductors and drivers. Finally, an estimate is made of the "sudden death" rate from coronary heart disease in relation to uniform size in an attempt to assess the extent to which the difference in physique between conductors and drivers could conceivably account for the difference in their sudden death rates.

FIRST ATTACKS OF CORONARY HEART DISEASE AND OCCUPATION

Table I shows the rate of occurrence of all first clinical attacks of coronary heart disease in three main

TABLE I

FIRST CLINICAL ATTACKS OF CORONARY HEART DISEASE (AVERAGE ANNUAL RATES PER THOUSAND) 4 YEARS' EXPERIENCE IN LONDON BUS CONDUCTORS AND DRIVERS, MEN AGED 35–64, 1949–50 AND 1955–56

Age Group (yrs)	Conductors						Drivers					
	Average No. of Men	Angina Pectoris	"Coronary Thrombosis"		Total First Attacks		Average No. of Men	Angina Pectoris	"Coronary Thrombosis"		Total First Attacks	
			Coronary occlusion, Myocardial Infarction, etc.	Sudden Deaths	Number	Rate per 1,000 per annum			Coronary occlusion, Myocardial Infarction, etc.	Sudden Deaths	Number	Rate per 1,000 per annum
35–44	4,033	*(0·0)*	*(0·3)*	*(0·1)*	6	*(0·4)*	5,468	*(0·1)*	*0·5*	*(0·2)*	17	*0·8*
45–54	2,783	*(0·5)*	*1·4*	*(0·7)*	29	*2·6*	5,454	*(0·2)*	*1·9*	*1·0*	68	*3·1*
55–64	1,802	*2·5*	*3·1*	*(0·5)*	44	*6·1*	3,400	*1·4*	*4·4*	*2·0*	106	*7·8*
Total 35–64	34,470†	*0·7*	*1·2*	*0·4*	79	*2·3*	57,286†	*0·5*	*2·0*	*0·9*	191	*3·3*

Notes: In all the Tables, unless otherwise specified, the data refer to the Central Buses, Trams, and Trolley-buses of the London Transport Executive, and rates where the number of deaths or cases is less than 10 are in brackets.

Medical diagnoses were obtained from general practitioners' and hospital and other specialists' certificates, and from the London Transport medical officers, who examine all men certified to be suffering from heart disease and certain "suspect" labels and all men whose absence for any cause exceeds 28 days before their return to work. Death certificates were available and, for almost every "sudden" death, the result of a *post mortem* examination.

†These figures give the total man-years of exposure in the two occupations.

clinical types: angina pectoris, coronary occlusion and myocardial infarction which was not immediately fatal, and "sudden death", *i.e.* death within 3 days of the onset of the first clinical attack. The comparison is between male conductors and drivers aged 35–64, of London's double-decker central buses, trams, and trolley-buses, and refers to the four years 1949–50 and 1955–56. The Table shows a lower first attack rate amongst the conductors in each age group if all three main types are considered together. This difference between the two occupations is, however, most marked for the sudden death rate, while the attack rate for angina pectoris is in fact greater at ages 45–64 in conductors than in drivers.*

If "coronary thrombosis" is taken to include sudden deaths as well as coronary occlusion, myocardial infarction, it will be seen that the combined rates are lower for conductors than for drivers. The difference is clearer than for all first attacks, but not so clear as for sudden deaths alone.†

"Sudden Death" and Occupation

Table II shows, for the 10 years 1949–58, sudden death rates from coronary heart disease in drivers and male conductors aged 35–64 years, based on a total of more than 200,000 man-years of experience.

The lower sudden death rate amongst conductors shown in Table I is confirmed in this 10-year experience. In round numbers the conductors' mortality is about half that of drivers. The difference is more noticeable at ages under 50.

Table II

SUDDEN* DEATHS FROM CORONARY HEART DISEASE 10 YEARS' EXPERIENCE IN LONDON BUS CONDUCTORS AND DRIVERS, MEN AGED 35–64, 1949–58

Age Group (yrs)	Conductors			Drivers		
	Average No. of Men	Sudden* Deaths	Rate per 1,000 per annum	Average No. of Men	Sudden* Deaths	Rate per 1,000 per annum
35–44	3,747	4	(0·1)	5,010	23	0·5
45–54	2,647	17	0·6	5,075	51	1·0
55–64	1,651	22	1·3	3,250	75	2·3
35–49	5,220	9	(0·2)	7,613	43	0·6
50–64	2,825	34	1·2	5,722	106	1·9
Total 35–64	80,452†	43	0·5	133,349†	149	1·1

*Deaths within 3 days of the onset of the first clinical episode.

†These figures give the total man-years of exposure, in the two occupations.

Physique and Occupation

Earlier observations made in 1954 on uniform sizes of bus conductors and drivers aged 25–64 (Morris and others, 1956) have now been extended to cover five central bus garages and three trolley-bus depots; and for the age group 55–64, a further three bus garages and two trolley-bus depots. These new observations refer to 1958 and bring the total number of men concerned up to 1,856 conductors and 2,673 drivers. The information available is the trouser size and jacket size for each man. Each size is *made* for a man with certain measurements (height, waist, and chest) but these measurements are not the exact measurements of the men to whom the garments are *issued*; nor, even if they were, would they be the ideal measurements for a scientific study of physique. They are tailors' measurements, and make an allowance for comfort of fit. Thus, a different waist measurement will usually be returned when a man is measured for a jacket compared with that used for his trousers. The waist measurement used in the present analysis is the measurement obtained from the trouser size, and the chest measurement that obtained from the jacket size. It was assumed that a man would reject a pair of trousers unless at the least they fitted reasonably at the waist, and a jacket if it was not roughly right across the shoulders and chest. Records of uniforms are amended each time a new one is issued.

Table III (opposite) shows the results for the trouser-waist measurements and Table IV (opposite) for the jacket-chest. In each Table the percentages at both ends of the scale are shown.

Table III shows that at each age there were *fewer* conductors than drivers with a 38″ waist or greater and *more* conductors than drivers with a 32″ waist or

*The numbers are too small to establish a statistically significant difference between conductors and drivers for the angina rate. The proportion of all first attacks which present as angina pectoris is, however, significantly higher in conductors than in drivers at ages 55–64 ($P < 0{\cdot}01$; $\chi^2 = 7{\cdot}6$).

†Rosenman and Friedman (1958) have noted that there was a higher total incidence of coronary heart disease in the men who worked on the central buses than in those who worked on the trams or trolley-buses as reported by Morris and others (1953). Moreover, the total incidence in the *central bus conductors* was higher than that in the *drivers of trams and trolley-buses*. Examination of the new data included in the present report together with the earlier data confirms the general finding that rates are higher for central buses than for trams and trolley-buses, though the difference is not significant ($P > 0{\cdot}05$). The excess in central bus conductors compared with tram and trolley-bus drivers is, however, due to the excess of angina pectoris which has been shown above to be commoner in conductors. The rate of sudden death, and the rate of infarction that was not immediately fatal, are both higher in tram and trolley-bus drivers than in central bus conductors.

The reason for the excess in central buses is obscure. It cannot be explained, as Rosenman and Friedman would have it, on the grounds that the central buses are "down-town" and the trams and trolley-buses "suburban". The trams (which were withdrawn during 1950–52) used to operate in some of the most congested areas of London while the so-called central buses operate over large areas which are at least as "suburban" as the tram and trolley-bus areas.

TABLE III

TROUSER-WAIST MEASUREMENTS OF UNIFORMS OF LONDON BUS CONDUCTORS AND DRIVERS, MEN AGED 25–64, 1954 and 1958*

Age Group (yrs)	Number of Men		Percentage with Trouser-waist 32″ or Less		Percentage with Trouser-waist 38″ or More	
	Conductors	Drivers	Conductors	Drivers	Conductors	Drivers
25–29	269	184	73	52	1·9	8·7
30–34	238	272	55	46	2·5	11
35–44	493	656	54	38	7·7	16
45–54	446	746	40	18	13	32
55–64	410	815	29	11	21	44
Total 25–64	1,856	2,673	—	—	—	—

*The measurements here analysed are for all the men of the relevant ages on the books of certain garages on a chosen day. The data for three garages (2 bus and 1 trolley-bus) are for January 1, 1954. The data for a further five garages (3 bus and 2 trolley-bus) are for January, 1958. The data for ages 55–64 include also yet five more garages (3 bus and 2 trolley-bus) also for January 1, 1958.

TABLE IV

JACKET-CHEST MEASUREMENTS OF UNIFORMS OF LONDON BUS CONDUCTORS AND DRIVERS, MEN AGED 25–64, 1954 and 1958*

Age Group (yrs)	Percentage with Jacket-chest 36″ or Less		Percentage with Jacket-chest 40″ or More	
	Conductors	Drivers	Conductors	Drivers
25–29	39	22	8·2	17
30–34	38	25	13	20
35–44	33	21	18	29
45–54	25	12	25	46
55–64	22	7·2	33	56

*The measurements here analysed are for the same men as in Table III.

less. Table IV shows the corresponding finding in terms of jacket-chest.

It will be seen that:

(1) The men's girth increased with age in both occupations.

(2) The girth of conductors was less than that of drivers.

(3) The difference between conductors and drivers was present in every age group, even the youngest; and the difference was as clear at 25–29 as at 55–64.

Differences in Height

In the earlier paper the percentage of men with large trouser-waists and jacket-chests were "standardized" or "adjusted" for height. That is to say, the fact that, on the average, drivers are taller than conductors (in small part because conductors over 6 ft tall are not recruited) was taken into account in the calculations. Since this correction made so little difference it has not been repeated. Fig. 1A and B (overleaf) shows, for the 1954 data, that the difference in girth was independent of differences in height. The men are divided into three height groups (based on uniform sizes)—5′10″ and over, 5′8″ and 5′9″, and 5′7″ and under. Within each of these, and for every 10-year age group, with one exception, the percentage of conductors with a 38″ trouser-waist or more was smaller than the corresponding percentage for drivers (Fig. 1A). Conversely (Fig. 1B), the percentage of conductors with a 32″ trouser-waist measurement or less was greater than the corresponding percentage for drivers (again with one exception).

The corresponding results were true for jacket-chest measurements of 40″ or more and of 36″ or less. Differences between drivers and conductors in height are therefore not important in these comparisons of girth.

Confirmation from Clinical Measurements

To test the use of uniform sizes as a method for comparing the physique of groups, and also to find out whether the difference between the uniform sizes of drivers and conductors might have been the result of a tendency on the part of drivers to take a more loosely fitting garment because they sit down while on duty and need room to manipulate a large steering wheel, whereas conductors might prefer a closer fit, information from another inquiry conducted by this Unit was used.

Since 1956 every case of coronary heart disease in conductors and drivers has been notified to us by the London Transport Executive and "matched" by six "controls" from his work-mates at the same garage. The men were also matched for age, job, and length of service. Controls were otherwise chosen at random, and were presumably healthy; at any rate they were working. If six such men could not be found we had to accept fewer. (The choice of controls from amongst a man s own work-mates was made in order to increase motivation for a high response. 93 per cent. of the men approached in fact agreed to be

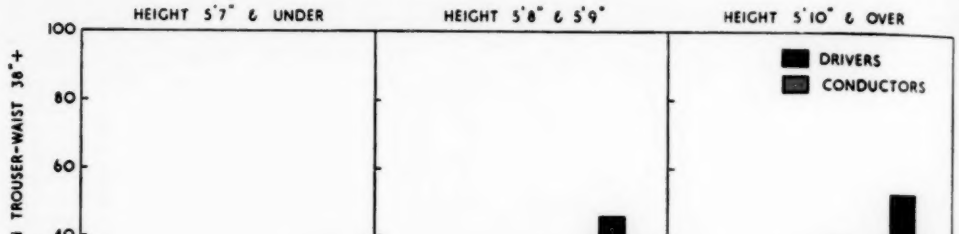

FIG. 1A.—Percentage of conductors and drivers with trouser-waist of 38" or more in three height groups*. London Transport Executive, 1954. Men aged 25–64.

**Note:* The numbers of men in the three height groups were as follows:

Height	Conductors	Drivers
5'7" and Under	384	317
5'8" and 5'9"	415	543
5'10" and Over	195	416
Total	994	1,276

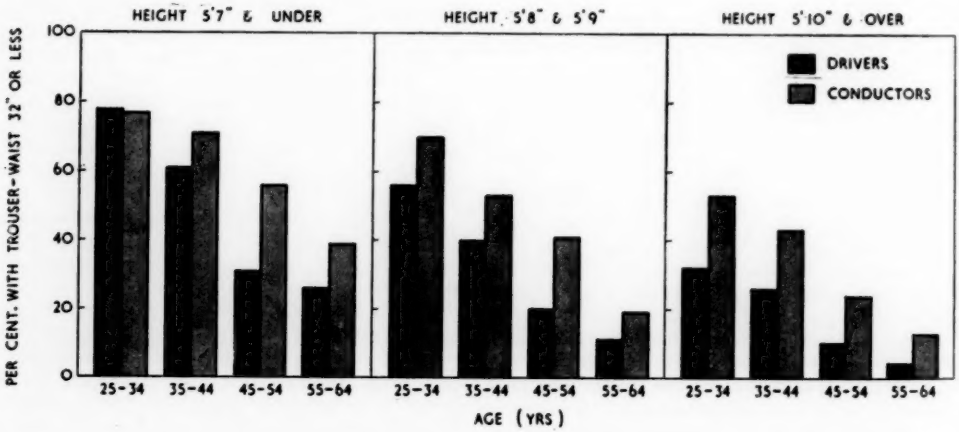

FIG. 1B.—Percentage of conductors and drivers with trouser-waist of 32" or less in three height groups. London Transport Executive, 1954. Men aged 25–64.

examined.) These men were visited at the garage by one of us, A.K., and examined clinically. Certain measurements were taken to determine somatotype, including measurements of waist and chest. At the time these measurements were taken no information was available about uniform sizes, but later it occurred to us to collect this information and to compare the *clinical* measurements with the trouser-waist and jacket-chest measurements of the most recent *uniforms* issued to the same men. All men examined up to a certain date were taken. There were 121 conductors and 244 drivers.

The results were encouraging. As was to be expected, the clinical measurements were smaller on average than the measurements of the uniforms, since there has to be some "slack" for comfort in wear. There were a few anomalies where the man's clinical measurement was greater than the corresponding uniform measurement; this, we assumed, was either because of error or because a man might choose to take a uniform which fitted him in certain important respects and have it altered in others if there were no standard size to fit him. The correlation between the uniform trouser-waist measurement and the clinical waist measurement was 0·88 for conductors and 0·86 for drivers; between the uniform jacket-chest measurement and the clinical chest measurement it was 0·75 for conductors and 0·78 for drivers. Classification of groups of busmen in terms of uniform measurement is not therefore likely to be misleading. Nor was there any apparent bias in the issue of uniforms—*i.e.* no tendency to issue drivers, for instance, with more loosely-fitting garments than conductors—as can be seen from Fig. 2. In this figure the uniform trouser-waist measurement is shown along the horizontal scale. Uniform trousers are made for men with waists of certain definite sizes, *e.g.* 32″, 34″, etc.—there are no fractional values. For each of these trouser-waist sizes, the average clinical waist measurement of the men issued with trousers of that size was calculated for conductors and drivers separately. This is the value shown on the vertical scale. It will be seen that the lines of averages for the drivers and conductors are practically indistinguishable. In other words, there is no tendency for a driver issued with a uniform with a certain trouser-waist measurement to be thinner (or fatter) than a conductor issued with trousers of the same waist measurement. The diagonal

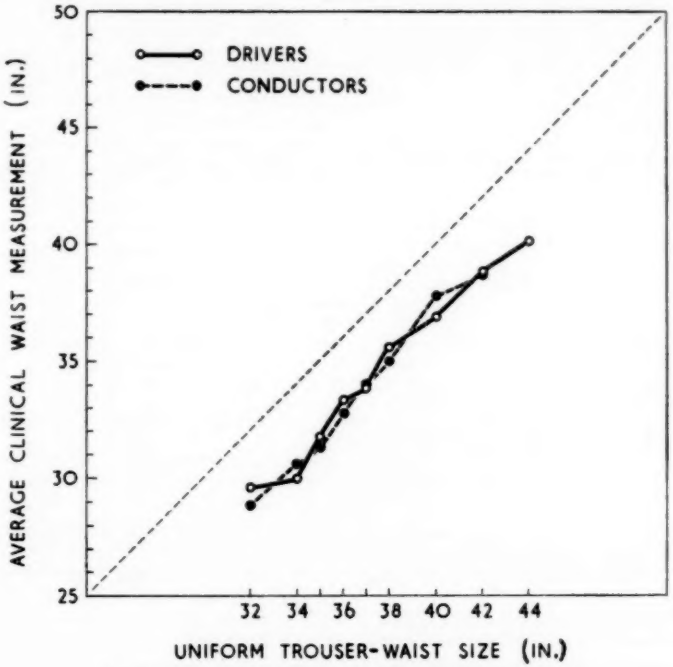

FIG. 2.—Comparison of trouser-waist size and clinical waist measurement. London Transport Executive, 1956–58. Men aged 40–64.

broken line shows where the mean would lie if the trouser-waist measurements were, on average, exactly equal to the clinical waist measurements of the man concerned, and it can be seen that the clinical measurements are on the average 3" less than the trouser-waist measurements.*

Physique by Direct Clinical Measurement

The clinical study mentioned above made possible a direct comparison of the clinical measurements of conductors and drivers, but the numbers are adequate only for ages over 40. Table V shows the comparisons for waist and chest measurements and confirms that, at the ages shown, conductors were smaller. Skinfolds were also measured at the clinical examination, and Table V shows that these measurements of body fat are smaller for conductors than drivers. Heights and weights are also shown, and again the conductors have the smaller measurements. Since weight is related to height (as also are waist and chest measurements) the ponderal index is shown. To the extent that this index eliminates the relationship between height and weight from the comparison it can be seen that conductors were on average lighter for their height than drivers.

There can, therefore, be little doubt that, whatever measure is used, conductors are thinner than drivers.

Conductors, Drivers who started as Conductors, and Drivers who started as Drivers

Drivers can be divided into those who joined the service as drivers and those who joined as conductors and subsequently became drivers.

Tables VI and VII (opposite) show that, in terms both of trouser-waist and jacket-chest measurements, drivers recruited from conductors were intermediate between conductors and drivers recruited directly as such. This was true at each age shown, though there are two minor irregularities in the age group 25–34 for small-chested men.

* Setting out this data in more formal terms, the regression coefficients of clinical measurements on uniform trouser waists are:

Conductors +1·047
Drivers +0·952

These are not significantly different ($0·2>P>0·1$). Using analysis of covariance it can be shown that the difference between adjusted means is 0·43 cm., which is not significant ($P>0·5$); *i.e.* allowing for the fact that, on the average, conductors are smaller than drivers, there is no significant difference between the two jobs in the clinical measurements of men issued with uniforms of the same size.

The standard errors of estimate are:

Conductors ±4·5 cm.
Drivers ±5·1 cm.

It might be thought more appropriate to look at it from the reverse point of view—*i.e.*, for a given *clinical* measurement, is a driver given a larger *uniform* than a conductor? Looked at this way, the regression coefficients of uniform trouser-waist on clinical measurement are:

Conductors +0·738
Drivers +0·783

These are not significantly different ($P>0·5$). The difference between adjusted means is 0·92 cm. That is to say, the drivers have the larger uniform trouser-waist for a given clinical measurement, but the difference is not significant ($0·1>P>0·05$).

The standard errors of estimate are:

Conductors ±3·8 cm.
Drivers ±4·6 cm.

In this analysis one conductor whose clinical waist measurement was returned as 189·8 cm. has been omitted, since it was assumed that there was an error. He has also been omitted from Table V.

Table V

CLINICAL MEASUREMENTS OF CONDUCTORS AND DRIVERS

Sample of London Busmen aged 40–64
Clinical Survey, 1956–59

Mean Measurements	Age Group (yrs)					
	40–49		50–59		60–64	
	Conductors	Drivers	Conductors	Drivers	Conductors	Drivers
Waist (cm.)[1]	80·5	86·0	82·1	88·9	83·2	88·2
Chest (cm.)[2]	95·5	97·6	92·5	97·0	90·9	95·8
Skinfold (mm.)[3]	34·5	43·3	36·1	46·9	34·0	43·8
Height (cm.)	171·0	172·6	170·5	171·4	167·3	170·4
Weight (kg.)[4]	69·5	73·2	66·3	73·8	64·0	70·6
Ponderal Index[5]	12·66	12·54	12·80	12·45	12·69	12·52
Numbers of Men (Range)	24–25	48–49	68–78	122–134	45–46	112–118

Notes:

1. Circumference 2" above pelvic rim, corresponding to position of a "tailor's waist" measurement, but no "slack" allowed. The subject stands relaxed.
2. Circumference at nipple level made at full inspiration. The subject stands and is instructed to expand the chest by breathing in deeply. The steel measure is pulled tight round the chest.
3. A total of three skinfold measurements: subscapular, triceps, and supra-iliac.
4. In trousers and socks but without shoes, minus 1 kg.
5. Height (in inches)/$\sqrt{}$ Weight (in pounds).

Significance of Differences: The differences between conductors and drivers are statistically highly significant for all six measures shown in the Table if account is taken of the consistency of the differences within age groups.

TABLE VI

TROUSER-WAIST MEASUREMENTS OF UNIFORMS OF CONDUCTORS, DRIVERS WHO STARTED AS CONDUCTORS, AND DRIVERS WHO STARTED AS DRIVERS, 1956 AND 1958, LONDON BUSMEN AGED 25–64*

Age Group (yrs)	Number of Men			Percentage with Trouser-waist 32″ or Less			Percentage with Trouser-waist 38″ or More		
	Conductors	Drivers Ex-Conductors	Drivers who started as Drivers	Conductors	Drivers Ex-Conductors	Drivers who started as Drivers	Conductors	Drivers Ex-Conductors	Drivers who started as Drivers
25–29	167	87	64	67	52	38	3·0	8·0	11
30–34	135	96	66	53	46	39	2·2	7·3	17
35–44	344	289	199	50	37	33	8·1	17	18
45–54	356	285	300	37	18	13	13	32	41
55–64	348	312	407	29	12	9·6	22	39	49
Total 25–64	1,350	1,069	1,036	—	—	—	—	—	—

*The measurements analysed in this Table are for the same garages as in Table III, except that one of the three garages in the 1954 sample is excluded. In 1954 no distinction was made between drivers who had been conductors and those who had not. Two of the three garages which were included in the 1954 sample are included in the 1956 sample here analysed.

TABLE VII

JACKET-CHEST MEASUREMENTS OF UNIFORMS OF CONDUCTORS, DRIVERS WHO STARTED AS CONDUCTORS, AND DRIVERS WHO STARTED AS DRIVERS, 1956 AND 1958, LONDON BUSMEN AGED 25–64*

Age Group (yrs)	Percentage with Jacket-chest 36″ or Less			Percentage with Jacket-chest 40″ or More		
	Conductors	Drivers Ex-Conductors	Drivers who started as Drivers	Conductors	Drivers Ex-Conductors	Drivers who started as Drivers
25–29	28	15	17	13	18	22
30–34	26	26	21	13	21	33
35–44	31	17	15	24	34	36
45–54	20	14	7·0	29	53	57
55–64	20	8·7	5·9	35	55	62

*The measurements here analysed are for the same men as in Table VI.

The suggestion in the earlier report (Morris and others, 1956) that drivers who had been conductors were similar to those recruited directly is not borne out in the present report on much larger numbers. There seems to be a real difference between the three groups. Hence, though conductors who chose to become drivers may not have been the same in terms of girth as drivers who were recruited directly, they were different from other conductors. In this connexion, it needs to be pointed out that all drivers recruited direct to the service had had driving experience, mainly heavy goods vehicle driving.

To sum up these differences in physique: in terms of uniform size and of direct measurement, conductors, age for age and height for height, had smaller waist and chest measurements than drivers. Skinfold measurements show that conductors also had less body fat than drivers. The difference in uniform size was present even at the youngest ages shown. Further, drivers who started as conductors were intermediate between conductors of the same age who remained conductors and drivers who were directly recruited from previous driving occupations.

CORONARY HEART DISEASE, PHYSIQUE, AND OCCUPATION

It is all too easy to assume, because there is evidence of some physical difference between conductors and drivers, that this difference accounts for the difference between the two groups of men in their experience of coronary heart disease (Keys, 1957; Reid, 1958; Brontë-Stewart, 1959). This, of course, is not necessarily so. It is necessary first to establish the relationship between physique and the tendency to suffer from coronary heart disease. This may not be by any means a simple relationship, and, even if it were, the occupational difference might yet be clear when men of similar physique were compared.

BUSMEN WITH CORONARY HEART DISEASE COMPARED WITH WORKING BUSMEN

The simplest way to test the hypothesis that girth, or fatness, is related to the occurrence of coronary heart disease is to compare the measurements of men with coronary heart disease with a group of normal

healthy men. This we have attempted to do by comparing clinical measurements and skinfold thicknesses of men who have had an attack of coronary heart disease with the "matched controls" discussed earlier. The results are shown in Table VIII.

TABLE VIII

CLINICAL MEASUREMENTS OF PATIENTS WITH CORONARY HEART DISEASE COMPARED WITH MATCHED CONTROLS, LONDON BUSMEN AGED 40–64, 1956–59

Mean Measurements	Grade	Patients with Coronary Heart Disease	Matched Controls
Waist (cm.)	Conductors	87·2	84·1
	Drivers	90·9	88·9
Chest (cm.)	Conductors	92·3	92·9
	Drivers	97·4	97·3
Skinfold (mm.)	Conductors	42·7	33·4
	Drivers	43·2	40·5
Height (cm.)	Conductors	169·0	169·6
	Drivers	172·2	171·9
Weight (kg.)	Conductors	68·4	66·5
	Drivers	75·0	73·7
Ponderal Index	Conductors	12·54	12·69
	Drivers	12·41	12·46
Numbers of Men (Range)	Conductors	23–27	112–136
	Drivers	31–33	161–175

Significance of Differences.—None of the differences between means of patients and controls is significant at the 0·05 level except for the skinfold where the difference is significant ($0·05 \geq P > 0·01$) for conductors but not for drivers.

The figures shown are for total skinfold: triceps, subscapular, and supra-iliac. For drivers there was no difference between cases and controls for any of the three individual skinfolds but, for conductors, there were significant differences for subscapular ($0·05 > P \geq 0·01$) and supra-iliac ($0·01 > P > 0·001$), but not for triceps.

Skinfold thicknesses were transformed using the formula $z = 100 \log_{10}$ (reading in 0·1 mm.—18), (Edwards, Hammond, Healy, Tanner, and Waterhouse, 1955).

Analysis of variance was used, and the matching variables—age, length of service, and place of work—were thus allowed for.

Note:
For definitions, see Table V.

In interpreting this Table, it should be remembered that, in each comparison between cases and controls, differences in the ages, jobs, length of service, and place of work of the men are automatically allowed for because of the method of matching. Discussion is therefore limited to comparison between cases and controls within occupations. Further, Table VIII deals only, so far as the cases are concerned, with men who survived long enough to be measured. This means for all practical purposes that all men who died within a month of the attack are excluded: in particular the rapidly fatal cases, which have been shown (Morris and others, 1953) to comprise some 30 per cent. of new cases, are missing. The Table, therefore, may not be typical of all new coronary cases among busmen. The measurements were taken between about 1 and 6 months after the incident.

With these provisos in mind, it will be seen from Table VIII that the waist and chest measurements of the coronary heart disease patients are not significantly greater than those of the controls, and also that there are no significant differences between patients and controls in height, weight, or ponderal index. On the other hand, skinfold thicknesses are greater for patients than for controls in conductors but not in drivers (see footnote to Table VIII). It is possible that the results for conductors are partly attributable to the disease, since the measurements of patients are made some time after the attack. Conductors will cease their relatively active occupation when they are ill and conceivably could put on fat; it has not been possible to test this notion. Sanders (1959) has shown that, in a group of ordinary healthy men taken from a general practice, all three skinfold measurements were significantly smaller than in men from the same practice who had coronary heart disease, allowance having been made for difference in weight, height, and age. There were no significant differences in terms of weight.*

SUDDEN DEATH RATES IN CONDUCTORS AND DRIVERS IN RELATION TO UNIFORM SIZE

A more direct attempt to show to what extent the differences in physique between conductors and drivers account for the difference between them in mortality from coronary heart disease is contained in Table IX (opposite).

As has been mentioned earlier, the clearest difference between conductors and drivers in their experience of coronary heart disease is in the sudden death rate in early middle age. Table IX therefore shows the sudden death rates in six categories for each of the two occupations—three categories of uniform size (trouser-waist) and two of age (under and over 50), cross-tabulated. It is thus possible to compare directly the sudden death rate of drivers and conductors in the same broad age group and in the same category of waist measurement.

Such a comparison involves certain technical difficulties:

(1) Information about the uniform sizes of drivers who died suddenly in 1949–52 was not available. Hence deaths of drivers in the second part of a period of rising mortality are compared with deaths of conductors over the whole period. (It was necessary to

*Acheson (1961), in a recent study of men aged 65–85 in Dublin, found no significant differences between men with coronary heart disease and controls in height, weight, or skinfold thickness, but there was a difference in ponderal index, the men with coronary heart disease being "stockier".

TABLE IX

SUDDEN DEATHS OF CONDUCTORS AND DRIVERS, AGED 35–64, IN RELATION TO UNIFORM TROUSER-WAIST MEASUREMENT, 1949–58*

London Busmen
Rates per thousand per annum (estimated)

Age Group (yrs)	Grade	Trouser-waist (in.)			
		32 or Less	34–37	38 or More	Total
35–49	Drivers	0·8 (11)	0·5 (10)	1·0 (9)	0·7
	Conductors	0·2 (5)	0·2 (4)	0 (0)	0·2
50–64	Drivers	2·2 (10)	1·2 (20)	2·7 (39)	2·0
	Conductors	1·4 (12)	1·0 (14)	1·3 (7)	1·2
Total 35–64	Drivers	1·1	0·8	2·0	1·2
	Conductors	0·5	0·5	0·7	0·5

* The figures for drivers refer to 1953–58 only.

Notes:

The numbers of deaths in the relevant categories are shown in brackets.

In the age group 50–64, no uniform size was available for one driver and one conductor amongst the men who died suddenly.

The numbers of men in the population with uniform trouser-waists of a certain range were estimated as follows. The number of men in a certain job and of a certain age (*e.g.* conductors aged 50–64) *in the population* was multiplied by that proportion *in the sample* of men of this age and job who had uniform trouser-waists in a certain range (*e.g.* 32" or Less), assuming the sample to be representative of the whole.

consider the deaths of conductors in the whole 10-year period because the numbers were so small.) This might spuriously increase the drivers' rates relative to the conductors'. Calculation, however, shows that this does not matter.

(2) The denominators of the rates are estimated from samples and not complete counts. Sampling errors cannot be calculated since the samples are not random, but the results from different garages and in the two different samples (1954 and 1958) are consistent.

Table IX, nevertheless, shows a clear result. In every one of the six possible comparisons the sudden death rate of conductors is less than that of drivers, though, of course, with such small numbers of deaths by no means all these differences are statistically significant and, indeed, some of them are small. It is clear, therefore, that the difference between conductors and drivers in their sudden death rates, though it may be in part accounted for by differences in physique, is none the less clearly present when such differences have been allowed for.

There is also evidence in Table IX that the relationship between waist measurement and sudden death from coronary heart disease may not be a simple one. For although the death rates of the "fat" men (38" or More) are nearly all greater than those of the "medium" men (34"–37"), so also are the rates of the "thin" men (32" or Less).

Similar Tables to Table IX for jacket-chest size are not printed; they show an equally clear difference between conductors and drivers in all possible comparisons.

Analyses of *all first attacks together*, also not shown, show a lower incidence in conductors than in drivers in five of the six comparisons in terms of trouser-waist, the exception being the "fat" conductors aged 50–64, who have a higher incidence than drivers. In terms of jacket-chest, the conductors have a lower rate in all six comparisons. Numbers are small and few of the differences are significant.

Summing up the interrelationships between coronary heart disease, physique, and occupation:

(1) Differences in waist and chest measurements and skinfold thickness between conductors and drivers seem clear in health.

(2) The only significant difference in physique found between the survivors of coronary heart disease and the controls was that the skinfold measurements for surviving conductors were on average greater than the skinfolds of the control conductors.

(3) The sudden death rates of conductors are lower than those of drivers with similar waist measurements.

DISCUSSION

The data in this paper refer only to London busmen and the interaction between coronary heart disease, physique, and occupation in these men. A study of bus conductors and drivers would be of limited interest were it not that differences between them in mortality from and incidence of coronary heart disease were the initial observations which led to the setting up of a hypothesis that physical activity of work is a protection against developing the disease.

It is important to stress that the hypothesis about the importance of physical activity does not depend only on the differences observed in conductors and drivers. It has been tested by contrasting the incidence of coronary disease in other occupations which differ in physical activity (postmen as compared with post office telephonists or civil service executive officers or clerks); by using the statistics of occupational mortality for England and Wales, both for 1930–32

and for 1949–53, and comparing, within social classes, the mortality from coronary disease in three groups of occupations distinguished by the physical activity typically involved in them; by relating the length of history of the disease in men dying of it to the physical activity involved in their work; and by relating ischaemic myocardial scarring on necropsy to occupation in men dying from causes other than coronary heart disease (Morris and others, 1953; Morris and Crawford, 1958). In all these varied tests the hypothesis has been upheld and it is therefore by now independent of the contrast between conductors and drivers.

It is, nevertheless, interesting to study bus conductors and drivers in greater detail and to find out whether they differ in other ways than their experience of coronary disease and their occupation. It is relatively easy to do so since the London Transport Executive have excellent records and encourage further study. Much information is available from the clinical survey of this Unit referred to earlier.

From the data presented in this paper it is clear that the two occupations differ in *physique*, and that this is true for all ages in the working span. Drivers differ also amongst themselves, those who have been conductors being closer in physique to the conductors than are the drivers who were recruited directly from other driving work. Conductors have lower casual blood pressures, lower blood lipid values, and lower haemoglobin levels than drivers (Morris, 1959; Kagan, 1960). On the other hand, so far as can be seen from preliminary studies (Bramwell, 1961), the diets in the two occupations are remarkably similar. Further speculation about the extent to which the differences in physique are due to differences in the occupation of driving as compared with that of conducting, or are present when the men join because different sorts of men choose different sorts of work and then do different things—*i.e.* the question of constitutional factors in relation to environment, can be postponed because further information is now being gathered. It is likely that both effects are at work. Meanwhile the important point is not "How does the difference in physique arise?", but "Is the difference big enough to explain the difference in coronary disease?". Table IX shows that, in respect of sudden death at least, and here the occupational difference is clearest, the difference in mortality remains substantial even when men of similar physique are compared, so that, though differences in physique may account for a small part of the difference in mortality, they do not come near to explaining it.

The technique of classification of physique in terms of uniform size has now been validated by direct comparison with clinical measurements in the same individuals. The agreement between the two types of measure was shown to be good enough for epidemiological purposes where the main emphasis is on contrasting the results for men at opposite ends of the scales of measurement. As important in the present context is the fact that there was no bias in the issuing of uniforms which might be related to the different work of conducting and driving. The main advantages of the method are twofold. It is easy—a purely clerical procedure—to get information about large, complete populations; and the information about the sick members of the populations refers to measurements made before the onset of clinical disease—a particularly important point in coronary heart disease, where some 30 per cent. die early in their first clinical attack (Morris and others, 1952, 1953). Moreover, any wasting or other change in physique, which occurs as a result of the disease, does not affect the measurements. In fact the method has some of the advantages of the prospective method of study while retaining some of the practical advantages, such as speed and cheapness, of the retrospective study. Since information can be obtained for complete populations, different populations can be compared or, because data are available for the population at risk, incidence, mortality, and prevalence rates can be calculated within a population. In the present paper, samples of the population were used to estimate rates.

The data in this paper which compare the physique of men with and without coronary heart disease are, of course, limited. They relate to simple measures of circumference of chest and waist and to height, weight, and body fat, the subtleties of somatotyping being missed. The comparison of sudden death rates in Table IX has, however, the great advantage of referring to all such deaths arising in a defined population group in a defined period. In representativeness, therefore, these figures make up for lack of subtlety and precision and the result is clear. The suggestion in Table IX that "medium" men—those who are neither "thin" nor "fat"—have the lowest sudden death rates, *i.e.* that it is not necessarily the thin ones who have the best prospects of escaping the disease, is interesting, but must be regarded as no more than a hint and a reminder that it is premature to assume that the relationship between physique and coronary heart disease is simple.

Summary

(1) The rate of occurrence of first clinical attacks of coronary heart disease for the 4 years 1949–50 and 1955–56 is shown for the men aged 35–64 who

worked on London's double-decker buses, trams, and trolley-buses. Conductors had a lower rate than drivers when all clinical manifestations of the disease were considered together, but they had a higher rate for attacks presenting as angina pectoris, particularly in the older age groups.

(2) "Sudden death" rates from coronary heart disease as the first clinical manifestation are shown for the 10 years 1949–58. Conductors had one-third the rates of drivers under 50 years of age and two-thirds of the rates at ages over 50.

(3) The physique of conductors was compared with that of drivers by comparing the sizes of their uniforms. In terms of the waist measurement of the trousers and the chest measurement of the jacket, conductors had a smaller girth than drivers at every age from 25–64. The data were obtained for all the men of the appropriate age on the books of thirteen bus garages and tram and trolley-bus depots, on certain specified days. The differences in physique between conductors and drivers at ages 40–64 were confirmed by direct measurement of samples of men. Skinfold measurements of conductors were also shown to be smaller than those of drivers.

(4) Uniform measurements were compared with clinical measurements in the same men. The uniform measurements were, of course, bigger but correlations between the two waist measurements were 0·88 for conductors and 0·86 for drivers, and between chest measurements 0·75 for conductors and 0·78 for drivers. There appeared to be no bias towards issuing drivers with garments that fitted more loosely because of the nature of their work.

(5) A comparison in terms of uniform size between conductors, drivers who started work as conductors, and drivers recruited directly as such, showed that the drivers who had been conductors were intermediate between the other two groups at every age from 25–64.

(6) Comparison of the clinical waist and chest measurements of men who had survived an attack of coronary heart disease and controls matched for age, job, length of service, and place of work showed no significant difference between patients and controls; nor did comparisons of height, weight, or ponderal index show any significant difference.

(7) A comparison of the skinfold measurements of men who had had an attack of coronary heart disease and these matched controls showed significantly greater measurements for patients than for controls in conductors, but not in drivers.

(8) Sudden death rates of conductors and drivers in two age groups and three categories of trouser-waist measurements were estimated. In each of the six possible comparisons, the sudden death rate for conductors was lower than that for drivers.

(9) Conductors are thus less liable than drivers to develop coronary heart disease and in particular to die suddenly from the disease. They measure less round the waist and chest than drivers, even when young. There is no clear relationship between the chance of developing coronary heart disease, or of dying from it, and the measures of physique used (with the possible exception of skinfold measurement). The difference between conductors and drivers in the sudden death rates cannot be explained by differences between the two occupations in physique as measured by uniform size.

We are very grateful to our colleagues in the London Transport Executive, particularly Dr. L. G. Norman, Chief Medical Officer, and Mr. C. J. Cornwall, Staff Administration Officer, and in the Social Medicine Research Unit, particularly Mrs. P. Parker and Miss M. Cayford (Computers), for much help.

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MATERNAL HEALTH IN EARLY PREGNANCY AND CONGENITAL DEFECT

FINAL REPORT ON A PROSPECTIVE INQUIRY

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Retrospective epidemiological studies of environmental influences upon human foetal development have so far proved to be of limited value. When routine ante-natal records were used for evidence of illness and other events in early pregnancy they were found not to contain sufficient information. Questioning mothers after delivery is unsatisfactory because their account of events in early pregnancy is liable to be coloured by the knowledge of whether or not their children are malformed. In addition, the interval between early pregnancy and delivery is too great for minor events and illnesses to be remembered accurately. A prospective survey of a large number of pregnancies was therefore undertaken to investigate associations between illnesses or other events during early pregnancy and foetal and infant death and defect.

The investigation was begun in 1952 in Watford, where for the 3 years 1952–55 women were interviewed at their first attendance at hospital and local authority ante-natal clinics; for 6 months in 1954–5 women were similarly seen at St. Albans City Hospital. In all, 3,295 women were interviewed, 3,055 of them by the author personally and the remaining 240 by two health visitors working under the author's supervision. Particulars about marital state, employment, previous pregnancies, history of illnesses, and whether the pregnancy was wanted were noted on a standard form. A detailed history was taken of experiences during the first 12 weeks of pregnancy, including illnesses, vomiting, fainting, injury or operation, anaesthetics, vaginal bleeding, attempts to induce abortion, coitus, and severe emotional upsets. Blood pressure, Rhesus group, Wassermann reactions, Kahn test, and haemoglobin estimation were recorded. The majority of the babies born locally in hospital were examined by a consultant paediatrician. For those born at home, in nursing homes, or in other areas, reports were obtained from health visitors about examinations made by general practitioners and clinic doctors. The results of this investigation have been published (McDonald, 1958). The main positive findings were an association, significant at a 5 per cent. level, between the maternal factors of febrile illnesses, pulmonary tuberculosis, and employment in laundries, and serious malformations in the children. Because certain defects are not always evident in the neonatal period, a further review was planned of the same children when they were older.

METHOD

The report obtained on each child in the neonatal period will be referred to as the first report. By 1959, when the children were aged 3 to 6 years, a second report was sought on each child. In getting information about defects noted in the children at this age, no reference was made either to the ante-natal record or to the first report. The school health records were inspected of all children still living in the Watford area who had been medically examined at school. Health visitors using a standard questionnaire reported on children living in the Watford and St. Albans areas who were not yet at school or who had not been medically examined. Children who had moved out of the area but whose addresses were known were also reported on by health visitors. When the address of the family was unknown, other means were used to get in touch with the mother and obtain a report from her on the child's development. Except when the child was illegitimate or adopted, letters and questionnaires were sent to mothers through appropriate local Executive Councils. When there was any doubt about a defect or the letter did not reach the mother an inquiry was made from the general practitioner with whom the child was registered.

For children who were examined by health

visitors or who were followed by means of letters to the mother, questions were asked about the age at which the child walked unsupported and made brief sentences, any history of operations or convulsions, any defect found at clinical examination, and any abnormality of gait, manipulation, speech, vision, and hearing. Further inquiries were made from school medical officers, family doctors, and consultants to obtain as much information as possible about any reported abnormalities. Certain groups of children were personally examined for evidence of mental defect, cerebral palsy, deafness, and congenital heart disease; the children selected were those who did not walk alone until after their second birthday, those with abnormalities of gait, those with marked delay in learning to speak or severe speech defects, those suspected of mental retardation, and those with heart murmurs who had not had cardiological investigations. At this stage the first reports were inspected and children who were said to have had a heart murmur in infancy were also selected for examination.

The 3,295 women originally interviewed had at the time of the first report 3,081 surviving infants about whom information was available (Table I).

TABLE I

PREGNANCIES STUDIED AND SURVIVORS TRACED

No. of Women originally interviewed			3,295
Found not to be pregnant	17	151	
Outcome of pregnancy not known	62		
Abortion—Spontaneous	68		
Therapeutic	3		
Maternal and foetal death	1		
Pregnancies of 28 weeks or more *or* resulting in live-born child	3,144		3,179
Add Twins	35		
Stillbirths	63	98	
Neonatal deaths	35		
No. of Surviving Infants on whom a First Report was Obtained			3,081
Failure to trace	148	175	
Death	27		
No. of Children on whom a Second Report was Obtained — Health Visitor	2,258		2,906
School Records	474		
Mother	89		
Family Doctor	85		

For 148 (4·8 per cent.) of the 3,081 survivors, no information was obtained after the neonatal period. Of these, 44 (30 per cent.) were known to have emigrated, nine (6 per cent.) to have been adopted, and one to have changed his name. In addition, 29 (20 per cent.) were illegitimate and further searching for them was undesirable. The remaining 65 (44 per cent.) had moved from the area and could not be found.

Illegitimacy was, therefore, an important reason for failure to trace children. Only 84 per cent. of the children of the 224 women who admitted to extramarital conception were traced, compared with over 95 per cent. in the whole series. As far as the maternal factors were concerned, the proportion of children untraced was slightly, but not significantly, raised among women who were Rhesus negative, who had anaemia, and who were employed. Apart from these the proportion untraced was approximately 5 per cent. in the remainder and there was therefore little evidence of important selective factors.

Another 27 of the 3,081 surviving children had died.

Second reports were obtained from health visitors, mothers, family doctors, and school health records for 2,773 children aged 3 to 6 years, and the health visitors completed reports based on their own records for 133 children who had removed to unknown addresses after the age of one year, making a total of 2,906.

RESULTS

INCIDENCE OF FOETAL AND INFANT DEATHS

63 infants were stillborn (a stillbirth rate of 20 per thousand births) and 55 died before their first birthday (an infant mortality of 18 per thousand live births). In 1953–4 in the Borough of Watford, where over half the births in the survey took place, the stillbirth rate was 19 and the infant mortality rate 22.

About one-quarter of the infants who were stillborn or who died later had gross malformations (Table II). One-third of the infants who died in the neonatal period weighed under 3 lb. After the first 4 weeks of life infections accounted for nearly half the deaths. Two (29 per cent.) of the seven children who died after the age of one year had leukaemia, but the *x*-ray exposure of the mothers of these children was not known.

TABLE II

ASCRIBED CAUSES OF 125 STILLBIRTHS AND DEATHS (Per cent.)

Cause		Stillbirth	Death		
			First 4 wks	4 wks–1 yr	1 yr and Over
Gross Malformation		25	20	27	29
Intracranial Trauma		13	18	—	—
Rhesus Isoimmunization		13	3	—	—
Birth Weight under 3 lb. (excluding above)		10	33	—	—
Asphyxia and Atelectasis		14	15	—	—
Infection		—	10	47	42
Other		25	2	26	29
Total	Per cent.	100	100	100	100
	Number	63	40	15	7

INCIDENCE OF DEFECTS

The abnormalities noted are listed in Table III. A few groups are omitted: undescended testis, because it was not looked for systematically; speech defects, because of difficulty in definition; and mental retardation not amounting to ineducability, because some of the children were only 3 years old and thus too young for adequate ascertainment. Other diagnostic groups such as fits, hernias, asthma, and eczema, were included because although they are not generally considered as congenital defects it seemed that ante-natal factors might play some

TABLE III

DEFECTS FOUND IN 3,179 LIVE AND STILLBORN CHILDREN

Class	Defect	Total Number of Children with Defect	Number of Children with This Defect Only	Found at First Report	Confirmed at Second Report ( )=died	Not Noted at Second Report	First Noted at Second Report	Total Incidence of Defect (per thousand)
A	Central Nervous System							
	Anencephalus	8	7	8	(8)	—	—	2·5
	Spina bifida	7	7	—	1 (6)	—	—	2·2
	Hydrocephalus (without spina bifida)	5	5	2	(2)	—	3	1·6
	Encephalocoele	1	1	1	(1)	—	—	0·3
G	Mongolism	6	4	6	5 (1)	—	—	1·9
A	Mental Defect (ineducable) excluding Mongolism	11	4	—	—	—	11	3·5
G	Cerebral Palsy	8	5	—	—	—	8	2·5
E	One fit or more at 3 years or over, or							
Fits	three or more episodes under 3 years	31	24	—	—	—	31	9·8
G	Less than three episodes at under 3 years	43	40	—	—	—	43	13·5
A	Oesophageal Atresia and Tracheo-oesophageal Fistula	3	2	3	1 (2)	—	—	0·9
A	Genito-urinary Defects							
	Urethral stricture, hydronephrosis, and hydroureter	3	1	1	(1)	—	—	0·9
	Absent kidneys and ureters		—	1	(1)	—	—	
	Hydronephrosis and hydroureters		—	1	(1)	—	—	
A	Hypospadias	5	5	4	4	—	1	1·6
A	Congenital Heart Disease							
	Coarctation of aorta	1	1	1	(1)	—	—	4·7
	Atresia of aortic valve	2	1	2	(2)	—	—	
	Transposition of great vessels	1	1	1	(1)	—	—	
	Interventricular septal defect	2	—	2	(2)	—	—	
	Tetralogy of Fallot	1	—	1	1	—	—	
	Patent ductus arteriosus	1	1	—	—	—	1	
	Pulmonary and aortic stenosis, interventricular septal defect, and anomaly of great vessels	1	1	1	(1)	—	—	
	Pulmonary stenosis	1	1	—	—	—	1	
	Atrial septal defect	1	1	1	1	—	—	
	Not known (with mongolism)	2	—	2	(1)	—	—	
	Systolic murmur with clinical enlargement of heart	2	2	—	—	—	2	
A	Systolic murmur only	12	9	—	3	—	9	3·8
A	Hare Lip and Cleft Palate	3	2	3	2	1	—	1·9
	Hare lip	1	—	1	(1)	—	—	
	Cleft palate	1	—	1	(1)	—	1	
	Bifid uvula	1	1	1	1	—	—	
A	Diaphragmatic Hernia	2	1	2	(2)	—	—	0·6
A	Pyloric Stenosis	19	15	2	2	—	17	6·0
B	Musculo-skeletal Defects							
	Congenital dislocation of hip	3	3	—	—	—	3	6·6
	Talipes	7	6	—	3	3	1	
	Digital defects	9	9	5	1	4	4	
	Deformities of chest wall	11	8	—	—	1	10	
	,, ,, spinal column	2	2	—	—	—	2	
	,, ,, skull	1	—	—	—	—	1	
	Hypertelorism	1	1	—	—	—	1	
	Micrognathia	1	1	—	—	1	—	
	Absent pectoralis major	2	2	—	—	2	—	
	Shortening of one lower limb	2	1	—	—	—	2	
	Tail	1	1	—	—	1	—	
	Cleido-cranial dysostosis	1	1	—	—	—	—	

TABLE III—*continued*

DEFECTS FOUND IN 3,179 LIVE AND STILLBORN CHILDREN

Class	Defect	Total Number of Children with Defect	Number of Children with This Defect Only	Found at First Report	Confirmed at Second Report ( )=died	Not Noted at Second Report	First Noted at Second Report	Total Incidence of Defect (per thousand)
C	Hernia Umbilical	40	37	19	2	13	21	12·6
	Inguinal	37	30	4	3	1	33	12·3
B	Naevus (more than 2 in. diam.)	29	27	—	3	11	15	9·1
A	Deafness (perceptive)	1	1	—	—	—	1	0·3
	Eye Defects							
A	Cataract (bilateral)	1	—	—	—	—	1	0·3
A	Nystagmus	2	1	—	—	—	1	0·6
D	Squint	83	70	—	—	—	83	26·1
D	Refractive Error (without squint)	31	24	—	—	—	31	9·8
D	Ptosis	3	1	—	—	—	3	0·9
F	Asthma or Eczema	77	63	—	—	—	77	24·2
B	Miscellaneous Defects							
	Branchial cyst	1	1	—	—	—	1	11·1
	Other cysts	11	10	—	—	3	8	
	Pilonidal sinus	5	4	—	1	3	1	
	Hiatus hernia	1	1	—	—	—	1	
	Hydrocoele	6	6	—	—	1	5	
	Tongue-tie (operation)	2	1	—	—	—	2	
	Diabetes (onset at 3 yrs)	1	1	—	—	—	—	
	Coelic disease	1	1	—	—	—	—	
	Diverticulitis	1	1	—	—	—	—	
	Other	5	5	—	1	3	1	
Children with Single Defect			464					
Children with More than One Defect			47					
Total Children with a Defect			511					160·7

part in their aetiology. 29 children (9 per thousand total births) had malformations which resulted in death either before or after birth; the diagnosis in many of these was made or confirmed at *postmortem*. In the surviving children who were traced a comparison of findings in the first and second reports was possible.

The incidence of gross malformations of the central nervous system was 6·6 per thousand births (anencephalus 2·5, spina bifida 2·2, hydrocephalus alone 1·6). All these defects (the majority being lethal) were noted in the first report, except for three children with hydrocephalus considered to be of congenital origin which was noted only in the second report. All six (1·9 per thousand) cases of mongolism were noted in the first report. In addition to five surviving children with mongolism, eleven (3·5 per thousand) children were found at the second report to have an intelligence quotient estimated at under 50 per cent. Two of these had cerebral palsy with fits and another three had fits; two of the six remaining children were possibly psychotic rather than mentally deficient. Eight children in all (2·5 per thousand) were found to have cerebral palsy: four had spastic hemiplegia, two spastic diplegia, and two bilateral athetosis.

Nearly all children suspected of deafness or with a marked speech defect were carefully examined using a special hearing test and when necessary audiometry, but apart from a mild high-frequency deafness in a child with bilateral athetosis following kernicterus due to Rhesus isoimmunization, only one child with perceptive deafness of unknown origin was found (0·3 per thousand).

As expected many cases of congenital heart disease were missed in the first report, and in a number of children the diagnosis is still incomplete as it was not felt justifiable to suggest cardiological investigation of systolic murmurs in children without symptoms or other abnormal clinical signs, or even to inform mothers if they were unaware of them. Fifteen children (4·7 per thousand) appeared to have definite congenital heart disease, although in four (including two children with mongolism) the exact diagnosis is uncertain. In four children no abnormality had been noted in the first report. There were twelve children (3·8 per thousand) who had systolic murmurs but no symptoms or other abnormal signs; only three of these had been noted in the first report.

There were six children (1·9 per thousand) with hare lip or cleft palate of some degree. One child, stated in the first report to have a cleft palate and

hare lip, was found at the second report to be normal, the mistake having been due to the confusion of two children with the same name. Nineteen children (6·0 per thousand) were reported to have had pyloric stenosis: fifteen had been treated surgically and four medically.

Three cases of congenital dislocation of the hip (0·9 per thousand) were noted at the second report. Talipes was noted at the first report in six children, but at the second report three of these were said to be normal, the condition probably being mild or successfully treated; one additional case was found at the time of the second report making a total of seven (2·2 per thousand).

Of the five boys with hypospadias, four were noted in the first report and one later. The serious eye defects, including the one case of cataract and two of nystagmus, were all first noted in the second report. The incidence of squint was found to be 26·1 and of refractive errors without squint 9·8 per thousand births.

An umbilical hernia was noted in the first report in nineteen children but in only two of these was it also noted in the second report. In 21 children it was noted only in the second report. In all, 38 children (12·6 per thousand births) were reported to have had at some time an umbilical hernia and of these about half were treated by operation. Inguinal hernia was described in three children in the first report, and 35 in the second—a total incidence of 12·3 per thousand births. Eczema or asthma was reported in 83 children (24·2 per thousand).

The ascertainment of the more serious malformations at the time of the first report is likely to be relatively complete. As the outcome of over 98 per cent. of the pregnancies was known, the incidence found of these malformations probably gives a fairly true picture of the children of the women in the survey. Although there were many domiciliary births in the series, these were not fully represented as far as the community was concerned, which introduces a slight bias in the series towards hospital births probably involving a small excess of primiparae and women of high parities and with previous obstetric complications. The influence of these factors on the incidence of malformations is probably small, but they would tend to raise the incidence of stillbirths and neonatal deaths.

Factors likely to influence the completeness of ascertainment of defects are the nature of the defect, age of the child and methods used. In the 133 children about whom information was obtained from existing health visitors' records, fifty per thousand were reported to have defects, whereas the incidence reported in the others was 160 per thousand. Although the overall incidence of defects and disorders reported varied little (ranging between 136 and 160 per thousand) at 3, 4, 5, and 6 years, the relative proportions of the different disorders varied at different ages (Table IV). As would be expected, visual defects and asthma were diagnosed more frequently in the older children and eczema in the younger ones, and this would lead to an underestimate of the true incidence of these troubles. Squints, hernias, and convulsions were reported at a more constant rate at different ages.

When the results of school medical inspections and general practitioners' reports combined were compared with information received through health visitors and mothers (Table V, opposite), it was evident that the incidence of asthma, eczema, convulsions, and visual defects was either understated in school medical and general practitioners' reports or over-reported by health visitors and mothers (the former would seem more probable).

Only a rough comparison with the incidence of defects found in other series can be made because of the different methods of ascertainment and criteria used. The incidence of congenital heart disease in 5,000 infants examined at the age of one year in an

TABLE IV

INCIDENCE OF VARIOUS DEFECTS FOUND AT SECOND REPORT ACCORDING TO AGE OF ASCERTAINMENT

Age (yrs)	Number of Children	Incidence per Thousand Children								
		Asthma	Eczema	Fits *	Infantile Convulsions†	Hernia		Squint	Visual Defect without Squint	Children with One or More Defect
						Umbilical	Inguinal			
3	449	4	22	11	20	7	7	20	4	136
4	908	18	14	9	12	10	11	34	5	160
5	1,262	24	13	12	13	10	10	31	18	158
6	154	26	13	19	24	6	—	20	20	149
All Ages	2,773	19	15	11	14	10	10	30	11	150

* Fits: One fit or more at 3 years or over, or three or more episodes at under 3 years.

† Infantile convulsions: less than three episodes at under 3 years.

TABLE V

INCIDENCE OF VARIOUS DEFECTS FOUND AT AGE 5 ACCORDING TO METHOD OF ASCERTAINMENT

Method of Ascertainment	Number of Children	Incidence per Thousand Children							
		Asthma	Eczema	Fits*	Infantile Convulsions†	Hernia		Squint	Visual Defect without Squint
						Umbilical	Inguinal		
Health Visitor or Mother ..	765	30	17	20	17	12	8	30	25
School Medical Examiner or General Practitioner ..	497	14	8	2	4	8	12	30	8
All Methods	1,262	24	13	12	13	10	10	31	18

* Fits: One fit or more at 3 years or over, or three or more episodes at under 3 years.

† Infantile convulsions: less than three episodes at under 3 years.

investigation in New York was 8·3 per thousand total births (Richards, Merritt, Samuels, and Langmann, 1955).

The definition used included heart murmurs heard at all examinations and considered organic. The total incidence in the present series was 4·7 per thousand, or including all persistent heart murmurs, 8·5 per thousand. A comparison with the incidence of defects found among about 1,000 children carefully followed to the age of 5 years in Newcastle-upon-Tyne (Miller, Court, Walton, and Knox, 1960) reveals a fairly similar incidence of defects. The following are the rates per thousand from Newcastle, figures from the present survey being given in brackets:

Pyloric stenosis 3 (6), mongolism 4 (2), mental defect 5 (4), squint 47 (26), hypospadias 3 (2), asthma about 20 (asthma or eczema 24), congenital heart disease 3 (5), cleft palate 1 (2), and talipes 3 (2).

RELATIONSHIP BETWEEN MATERNAL CHARACTERISTICS AND EXPERIENCES IN PREGNANCY AND DEATH AND DEFECTS IN CHILDREN

The defects found in this series are numerically too few for significant associations to be found between maternal factors and individual defects, especially as some of the maternal factors under consideration occurred infrequently. For this reason the defects are grouped into Classes A to G (Table III).

Class A comprises serious or potentially serious defects of unknown aetiology, mainly those of the central nervous system and heart, and pyloric stenosis, mental defect, hare lip or cleft palate, and hypospadias.

The majority of the defects in Class B are of the skeleton and superficial structures.

Hernias (C), eye defects (D), fits (E) defined as one fit or more at 3 years or over or three or more episodes under 3 years, and asthma or eczema (F) are considered as separate categories.

Mongolism, because of the chromosomal anomaly which has been observed, cerebral palsy, because of its association with peri-natal events, and infantile convulsions (less than three episodes under 3 years), because of their minor nature, were placed in Class G and not analysed with the other defects.

(*i*) *Maternal Age.*—No statistically significant correlations with maternal age were found, but certain trends were noted.

The incidence of abortions rose with maternal age (Table VI, overleaf); this was at least partly due to a tendency for older mothers, especially those who had had previous abortions, to book early for their confinement. The incidence of stillbirths and neonatal deaths without malformations and that of asthma or eczema also tended to rise with maternal age. Among the individual defects, an association was noted with maternal age, especially in mongolism, and also in congenital heart disease excluding mongolism, hare lip or cleft palate, and cerebral palsy (Table VII, overleaf).

(*ii*) *Maternal Parity.*—The deaths and defects in the series were too few for separation of the effect of parity from that of age. Abortions and the group of stillbirths and neonatal deaths tended to be associated with higher parity as well as with age, and the increase in older mothers could therefore be due to either factor or to both. In the Class A defects, as no trend with parity was observed, the effect if real is probably due to age and not to parity. In asthma the incidence was lower in women of higher parity and any association thus appears to be with age rather than parity.

The well-known association of pyloric stenosis with primiparity is evident in Table VII.

TABLE VI

MATERNAL FACTORS IN RELATION TO FOETAL AND INFANT DEATH AND DEFECT

Maternal Factors		Number of Pregnancies	Incidence of Deaths and Defects (per thousand pregnancies)							
			Abortions (68 cases)	Stillbirths and Neonatal Deaths Without Defect (79 cases)	Malformations Class A ** (90 cases)	Malformations Class B (102 cases)	All Hernias Class C (77 cases)	Eye Defects Class D (113 cases)	Fits Class E (31 cases)	Asthma or Eczema Class F (77 cases)
		Total No. 3,251	21	24	28	31	24	35	10	24
Age (yrs)	Less than 25	1,269	13	19	29	32	23	31	8	19
	25–34	1,612	25	26	25	30	24	38	11	24
	35 and Over	370	30	35	35	32	24	35	11	38
Parity	1	1,362	21	23	32	29	26	32	9	24
	2 and 3	1,432	17	23	23	37	24	34	10	26
	4+	457	31	31	28	22	13	48	9	15
Employment—Full or Part-time		1,529	16	20	30	31	22	29	9	22
Work "Heavy"		264	19	19	38	45	19	42	0	19
"Unwanted" Pregnancy		921	20	26	30	29	25	40	7	27
Extra-marital Conception		224	9	13	31	36	36	36	4	13
Attempted Abortion		168	24	18	24	42	36	30	18	24
Rhesus Negative		542	26	**46†**	22	26	20	31	15	22
Chronic Illness at Onset of Pregnancy		430	16	28	40	33	30	35	**23†**	35
*§ Hypertension (diastolic BP 90 or more)		60	33	67	17	50	17	33	0	33
§ Anaemia (Haemoglobin less than 80 per cent.)		490	24	**39†**	29	33	14	41	10	20
*History of cold sores (herpes simplex)		336	27	15	24	27	18	24	0	18
History of pulmonary tuberculosis		61	33	0	**98†**	16	16	0	16	33
Illness, etc., during First 12 Weeks of Pregnancy	Acute Illness { Non-febrile	1,065	19	30	24	23	23	29	8	20
	Acute Illness { Febrile	148	**47†**	40	**61†**	41	20	**68†**	7	**61†**
	Vomiting	488	20	20	27	39	35	41	10	33
	Fainting	135	22	15	15	30	22	52	15	30
	Injury or Operation	143	28	0	35	42	21	35	21	14
	Anaesthetic	63	48	32	48	32	16	**95†**	16	16
	Vaginal Bleeding	523	**38†**	36	25	34	15	38	15	21
	Anxiety or "Shock"	444	27	29	20	38	18	41	7	27

* Blood pressure was recorded in approximately 50 per cent. of pregnancies and history of cold sores in about 30 per cent.

§ Blood pressure reading and haemoglobin estimation made at first ante-natal visit.

** For defects included under Class A, etc., see Table III. †Bold figures indicate $P \leqslant \cdot 05$.

(*iii*) *Employment.*—Nearly half the mothers were engaged in part-time or full-time work outside the home. The proportion employed depended largely upon parity and varied from 80 per cent. of women who were having their first child to 20 per cent. of women having a fourth or later child.

So far as the death or defect of their children was concerned, the experience of the women who were employed did not differ greatly from that of those who were not employed (Table VI). Allowance should be made for parity in any comparison, but the rates would not be substantially altered by this. The children of women who said their work involved heavy lifting or pulling had a raised incidence of Class A defects (38 per thousand compared with 28 per thousand in all children). This was not statistically significant, whereas neonatally an association significant at a 5 per cent. level had been observed between heavy work and serious malformations. The defects which tended to be associated with heavy work were those of the central nervous system and heart (Table VII). In the original communication it was noted that three out of the ten women doing heavy work who had defective children worked in laundries and that out of a total of 28 women who worked full-time in laundries, four (143 per thousand) had children with major malformations (anencephalus, hydrocephalus, cardiac defect, and hypospadias) compared with 28 per thousand in all maternities. This finding was unaltered by the results of the second report and the probability of its occurring by chance is small ($\chi^2 = 10 \cdot 2$; 1 d.f.; $P = \cdot 001$). Of the total of 15 women in the series who worked in laundries, five (18 per cent.) conceived out of wedlock, and fourteen (50 per cent.) reported an illness in the first 12 weeks of pregnancy, both rates being higher than expected. In three the illness was said to be febrile; one of

TABLE VII

SELECTED MATERNAL FACTORS IN RELATION TO CERTAIN TYPES OF DEFECT

Maternal Factors		Number of Pregnancies	Incidence of Defects (per thousand pregnancies)								
			Class A						Class B	Class G	
			Central Nervous System (21)	Heart (15)	Hare Lip and Cleft Palate (6)	Pyloric Stenosis (19)	Hypo-spadias (5)	Mental Defect* (9)	Talipes (7)	Cerebral Palsy (8)	Mongolism (6)
		Total No. 3,251	7	5	2	6	2	3	2	3	2
Age (yrs)	Less than 25	1,269	6	2	1	6	2	4	3	—	—
	25–34	1,612	8	4	2	6	1	1	1	4	2
	35 and Over	370	3	17	6	3	—	6	6	6	8
Parity	1	1,362	8	4	3	10	2	4	4	2	2
	2 and 3	1,432	6	4	1	2	2	1	1	3	1
	4+	457	7	9	2	7	—	5	2	2	7
"Heavy" work		264	15	12	4	8	4	—	12	—	4
Full-time employment in laundry		28	74	37	37	—	37	—	—	—	—
"Unwanted" pregnancy		921	7	8	3	9	2	4	3	4	6
Chronic Illness at Onset of Pregnancy		430	7	7	—	10	—	5	2	5	—
History of Pulmonary Tuberculosis		61	34	17	—	34	—	—	—	—	—
Illness etc. during first 12 weeks of Pregnancy	Febrile Illness	148	7	7	7	7	14	7	7	—	—
	Injury or Operation	143	—	15	7	—	7	7	—	7	—
	Anaesthetic	63	—	—	—	17	—	17	—	—	—

* Excluding mongolism and cerebral palsy

these resulted in abortion, but the children of the other two women were normal. The defects were distributed equally among women who reported illnesses and those who reported none. There was no excess of chronic illness or of anaemia among the laundry workers.

The incidence of Class B malformations was raised, although not to a significant level, in the children of women who said their work was heavy, but three of the mothers of the seven children with talipes said their work was heavy, whereas one in twelve would have been expected.

(*iv*) *Rhesus Negative Blood Group.*—Of the total of 3,251 infants, 542 were born to Rhesus negative mothers. The Rhesus negative mothers had, as would be expected, more than their share of stillbirths and neonatal deaths without defect (46 compared with 24 per thousand) ($\chi^2=13{\cdot}2$; 1 *d.f.*, $P={\cdot}003$). Ten deaths were due to Rhesus isoimmunization: eight were stillborn (five of them macerated), and of the two live births to women with raised antibody titres one infant died with tentorial tears and intracranial haemorrhage and in the other an exchange transfusion was attempted but the infant died one hour after birth. The incidence of Class A defects in the children of Rhesus negative mothers was 22 per thousand and thus about average. Only one of the eight mothers of children with cerebral palsy was Rhesus negative. This child had double athetosis following kernicterus.

(*v*) *Unwanted Pregnancy and Attempts to Induce Abortion.*—A little less than one-third of all the women said their pregnancies were unwanted. There appeared to be two main reasons for this: some women, particularly the older ones, thought that they already had enough children, and others, who tended to be among the younger ones, were unmarried or living under unsatisfactory conditions. The women whose pregnancies were unwanted were asked whether they had attempted to procure an abortion; 168 women admitted to having tried, mainly by taking drugs (ranging from castor oil to special drugs thought to be abortifacient) or by vaginal douching, only a few having tried other mechanical means. Of the women who admitted to attempting to induce abortion, four actually did abort and one had a therapeutic abortion on psychiatric grounds. In the remainder, pregnancy proceeded and apart from an increased incidence which did not reach a 5 per cent. level of significance of Class B defects, hernias, and fits, their children had no more defects than the others.

(*vi*) *Chronic and Previous Illness.*—430 women said that they were suffering from a chronic illness at the beginning of their pregnancy. These illnesses were for the most part indefinite, the commonest being chronic coughs, catarrh and "nerves". More serious illnesses were less frequent. Children of women with a chronic illness had a slight, but not significant, excess of Class A defects (40 per thousand compared with 28 per thousand) and a significant excess of fits (23 per thousand compared with 10 per thousand) ($\chi^2 = 10{\cdot}9$; 1 *d.f.*; $P < {\cdot}001$). The conditions complained of by mothers did not, however, appear to differ from the general run—four had a cough, two had catarrh, one was "run down", one had a hydronephrosis, one pulmonary tuberculosis, and the last mitral stenosis.

HYPERTENSION.—Information about blood pressure at the first ante-natal visit was only available for 1,835 women as this observation was not made until nearly half-way through the survey. 60 women were recorded as having a diastolic pressure of 90 mm. or more at the first ante-natal examination; of these, two aborted and two had hysterotomies (one for hypertension and the other for eclampsia). The incidence among their offspring of stillbirths and neonatal deaths without defect was 67 per thousand compared with 24 per thousand total births, but the difference did not reach a 5 per cent. level of significance ($\chi^2 = 3{\cdot}5$; 1 *d.f.*; $P = {\cdot}06$). There was no evidence of any association of hypertension with defect, but the numbers were too small to detect any but a marked association.

ANAEMIA.—Women who were anaemic (as indicated by a haemoglobin value of less than 80 per cent. at the first ante-natal examination) had an excess of stillbirths and neonatal deaths (39 compared with 24 per thousand in all maternities ($\chi^2 = 4{\cdot}4$; 1 *d.f.*; $P < {\cdot}04$)). The incidence of defects among their children did not, however, differ from the children of women with haemoglobin levels of 80 per cent. or more.

SYPHILIS.—This featured insignificantly in this series. Of the nine women who had a positive Wassermann reaction or Kahn test in pregnancy, one had an infant who died neonatally with tentorial tears, one child was untraced, and the remaining seven were reported to be normal and without defect.

PULMONARY TUBERCULOSIS.—An excess of women with a history of pulmonary tuberculosis among the mothers of children with serious defects was noted in the original analysis. An excess of children with major defects was also observed among the previous pregnancies of these women. There were in all 61 women in the series who had or had had pulmonary tuberculosis; of these, two aborted and three had stillborn infants with serious defects (two were anencephalic and one had absent kidneys and a diaphragmatic hernia). At the second report one more child of a tuberculous mother was found to have a cardiac defect and two others pyloric stenosis, making a total of six Class A defects (98 per thousand) ($\chi^2 = 9{\cdot}2$; 1 *d.f.*; $P = {\cdot}002$).

The women with a history of pulmonary tuberculosis were divided into two groups: those whose tuberculosis was apparently healed and who were not attending a chest clinic more often than once a year, and the remainder. All but three of the 28 children of women with healed tuberculosis were traced and none had a Class A defect. Of the 33 women in the remaining group, two aborted and six of their 31 children had a Class A defect.

HERPES SIMPLEX.—About one-third of the women were asked whether they had ever had cold sores. Roughly one-third of those asked gave a positive history. These women had rather more abortions but fewer stillbirths and neonatal deaths and in general fewer children with defects than mothers with no history of cold sores.

ASTHMA.—33 women gave a history of asthma. The 22 women who said that they had had an attack of asthma during the first 12 weeks of pregnancy had three children (14 per cent.) who were reported to have asthma. None of the eleven children of women who gave a history of asthma in the past but none during pregnancy was reported to have asthma.

(*vii*) *Events in Early Pregnancy*

SEVERE EMOTIONAL UPSET.—In all, 444 women said that they had suffered from severe anxiety or shocks in early pregnancy. Nearly 7 per cent. of their children were untraced, which is probably because of the greater amount of illegitimacy among the untraced children; but the children who were traced had an average incidence of defects.

Much of the excessive anxiety in early pregnancy was associated with the pregnancy itself and the women who conceived out of wedlock had a great deal of worry. There was no excess of defects among the women who conceived out of wedlock apart from hernias.

COITUS.—The children of women who continued from their first missed menstrual period to have coitus at least once a week had an average incidence of foetal and infant death and defect. The outcome of the pregnancies of 233 women who abstained from coitus between the 4th and the 13th week of pregnancy differed from this in certain respects. The rate of abortions among these women was 43 compared with 21 per thousand among all the women, ($\chi^2=4\cdot7$; 1 *d.f.*; $P<\cdot03$ $>\cdot02$) and the incidence of stillbirths and neonatal deaths was decreased, but not significantly so. There were rather fewer defects among their surviving children. The excess of abortions was mainly in women who had aborted previously, and was perhaps accounted for by their having been told to take more care next time.

ACUTE ILLNESS.—The episodes of acute illness which occurred during the first 12 weeks of pregnancy were divided into those judged at the interview to be febrile and those in which there was no evidence of fever. Among the 148 pregnancies in which the women had had a febrile illness, the incidence of stillbirths and neonatal deaths was raised but not significantly so (40 compared with 24 per thousand). The incidence of abortions was significantly increased, 47 compared with 21 per thousand in all maternities ($\chi^2=4\cdot2$; 1 *d.f.*, $P=\cdot04$). Likewise the incidence of Class A defects was significantly raised to 61 per thousand compared with 28 per thousand ($\chi^2=5\cdot5$; 1 *d.f.*; $P>\cdot01<\cdot02$). Of the febrile illnesses 86 per cent. were respiratory infections and eight of the nine febrile illnesses followed by Class A defects were of this nature. Examination of the seasonal distribution of the respiratory infections showed that four-fifths occurred between October and March, and six of the eight febrile respiratory illnesses associated with these defects occurred during the 6 winter months. The two Class A defects associated with summer illnesses were tracheo-oesophageal fistula (May) and spina bifida (September). The children of mothers who reported febrile illnesses also had more than twice as much reported asthma or eczema ($\chi^2=8\cdot1$; 1 *d.f.*; $P=\cdot004$) and twice as many eye defects as other children ($\chi^2=4\cdot2$; 1 *d.f.*; $P=\cdot04$). The possibility that mothers of children with asthma or eczema reported more acute febrile illnesses because they booked earlier and therefore recalled better was examined but found not to be the case. These mothers did not book any earlier than the other mothers, and those who booked late gave in fact more often a history of febrile illnesses than those who booked early.

VOMITING.—The children of the 488 women who vomited during the first 12 weeks of pregnancy had an essentially average incidence of death and defect. There was a slight, but not significant, excess among them of asthma and hernias. When the group was broken down into 149 women with severe vomiting and 339 with mild vomiting, there was no suggestion that excessive vomiting was associated with any abnormality except asthma and here the association did not reach a 5 per cent. level of confidence.

FAINTING.—135 women said that they had lost consciousness at least once during the first 12 weeks of pregnancy. Among their children there was an average incidence of deaths and defects apart from a slight, but not significant, excess of eye defects.

INJURIES OR OPERATIONS.—143 women reported an injury or operation during the first 12 weeks of pregnancy. These women had slightly more than their share of abortions and defects of Class A and B (but not significantly so) but no stillbirths or neonatal deaths without defect.

About two-thirds of the injuries reported were due to falls, and about one-quarter were caused by road accidents of various sorts.

A few operations were reported during the first 12 weeks of pregnancy; two women who had had a major dental operation and a herniorrhaphy respectively had normal children, and one who had had an appendicectomy had a child with a minor visual defect. Three women with normal children had had cauterization of the cervix, but the only woman who had a tubal insufflation (done during the second week) had a child with an interventricular septal defect and cleft palate.

ANAESTHETICS.—Apart from a general anaesthetic for some of the operations mentioned above and in a few cases for reduction of fractures and excision of wounds, many dental extractions were performed under nitrous oxide anaesthesia. In all, 54 women were anaesthetized during the first 12 weeks of pregnancy. There was a slight, but not significant, excess of abortions and of Class A defects in their children and a significant excess of eye defects ($\chi^2=5\cdot5$; 1 *d.f.*; $P<0\cdot2$ $>0\cdot01$).

VAGINAL BLEEDING.—523 women reported bleeding from the vagina after what was considered to be the last menstrual period. Some association was observed with abortions (the bleeding was probably in some cases the first evidence of abortion) and with stillbirths and neonatal deaths without defect

($\chi^2 = 3{\cdot}5$; 1 *d.f.*; $P = {\cdot}06$) but none with serious defects, and there was no suggestion of an excessive incidence in any particular group of defects.

Discussion

Some caution is needed in the interpretation of the results of a survey of this type and size. The likelihood of finding by chance a statistically significant association between maternal factors and children with defects is increased when a large number of different factors and defects are examined. A greater difficulty is that, in the ascertainment of abnormalities in the children, a good deal of weight is given to what mothers report about their children, and it may be that the mothers who give the fullest history of events and illnesses in early pregnancy will also report more abnormalities in their children. At the same time, the incidence of abnormalities under consideration is so low that only a fairly definite association will reach a 5 per cent. level of significance in a survey of this size except when common maternal characteristics are examined.

As the characteristics and experiences of the mothers whose pregnancy terminated in abortion or in stillbirth or neonatal death without defect were discussed in the previous communication and the results were not affected by later findings, the present discussion will be limited to malformations and other abnormalities.

Malformations.—The likelihood of the association found between febrile illnesses and Class A defects occurring by chance is small, but there was no evidence in this survey to suggest that febrile illness played an important part in the causation of defects. Coffey and Jessop (1959) found 2·4 times as many defects among the children of women who reported influenza in early pregnancy compared with the controls. In this survey children of women with febrile illnesses had 2·2 times as many defects as other children. If febrile illnesses were an important aetiological factor, seasonal trends and yearly fluctuations dependent upon epidemics would be expected. There is some suggestion that anencephaly, which is a lethal and obvious defect suitable for study, behaves in this way (Edwards, 1958; McKeown and Record, 1951) but the mothers of the eight anencephalic infants found in the present survey gave no history of febrile illness.

The association noted between pulmonary tuberculosis in the mother and Class A defects in the child is supported by evidence from the previous pregnancies of the women with a history of tuberculosis. However, the total number of women in the series said to have had pulmonary tuberculosis was only 61 and more evidence on larger numbers is needed to exclude the possibility that the positive finding in this series was due to some associated variable or to chance alone. If the association were confirmed, it could be due to some constitutional factor predisposing to both tuberculosis and defective children, or it could be connected with the tuberculous infection or its treatment or conceivably to diagnostic *x*-rays.

The high incidence of serious malformations among the small group of women working in laundries presents a similar problem. The mothers were mostly primiparae, so that there was no evidence from the previous pregnancies. Any direct effect resulting from an occupational hazard seems unlikely. It is more probable either that these women differed from the rest in some way other than their employment or that working conditions in laundries favour some adverse environmental factor, or, of course, that it was a chance finding. Laundry workers reported more illnesses than expected in the first 12 weeks of pregnancy, but the defects were distributed equally among those who reported a febrile illness and those who reported none. The women working in laundries in this area probably came from an inferior social environment, but there was no evidence of excessive anaemia among them which might indicate a poor nutritional status.

The groups of women with children who had specific defects were numerically too small to reveal any but marked differences from the rest. In mongolism, now known to be associated with a chromosomal anomaly, the maternal age effect was noticeable. There was no indication of ill-health in the mothers which might be associated with the chromosomal anomaly.

In view of the theory of raised intra-uterine pressure perhaps associated with a strong abdominal musculature as a factor in the aetiology of talipes it is interesting to note that whereas one in twelve of all the women were employed in work which they considered heavy, three of the seven mothers of children with talipes were doing work of this nature.

Eye Defects.—Although the incidence of squints reported was fairly constant at different ages and using different methods of ascertainment, a substantial proportion of refractive errors without squint was certainly missed in the younger children. As there was selective reporting it is quite possible that mothers who were more concerned about their

own health during pregnancy would be more likely to worry about their children's eyes. This might explain the excess of reported febrile illnesses and also of anaesthetics which were mainly for dental extractions, but it is perhaps equally possible that there may be some aetiological connexion, and unlikely chance findings can certainly not be eliminated.

FITS.—The mothers of the 31 children who had a convulsion at 3 years or over or three or more episodes before the age of 3 years had reported an excess of ili-health of various types at the onset of their pregnancies. There would not appear to be any direct connexion between the rather vague and common conditions of which they complained and fits in the children, but it may well be that there is some indirect connexion between the two. However, the association observed is of a low order and may have arisen by chance.

ASTHMA OR ECZEMA.—The older age but lower parity of the mothers of children with asthma or eczema is consistent with a raised incidence of these conditions in the higher socio-economic groups.

Asthma or eczema were found to occur more commonly among the children of women who reported a febrile illness during early pregnancy than among those who reported none. There was no suggestion that these mothers booked earlier and therefore recalled their illnesses better. Three of the febrile illnesses were in women booking late when it was rare for a febrile illness to be reported; furthermore, febrile illnesses were in general less frequently reported by mothers over 30 than under 30, and the mothers of asthmatic children tended to be older. Perhaps the mothers of asthmatic children recalled their illnesses better than other mothers, or perhaps there is some connexion between susceptibility to infection and allergy.

The experience of this survey suggests that it is unlikely that a prospective inquiry, even based on much larger numbers, will show any important association with any ordinary events or maternal states such as vaginal bleeding, vomiting, anaemia, emotional stresses, and chronic illness, except possibly febrile illnesses, occupation, and pulmonary tuberculosis. Prospective inquiries may well be the most satisfactory method of testing hypotheses such as the possible connexion between virus infections and malformations. Promising hypotheses are unfortunately few and in the meantime more economical though less conclusive methods of searching for clues may prove more useful.

SUMMARY

The final results are presented of a prospective survey of maternal characteristics, and illnesses and events in the first 12 weeks of pregnancy in relation to death and defect in the children.

3,278 women were interviewed at their first antenatal visit and the immediate outcome of pregnancy, including the presence of any malformations observed in the infants, was ascertained in 98 per cent. The total number of infants born alive was 3,116. Later reports were obtained on just over 95 per cent. of these children (91 per cent. were aged 3 to 6 years at the time of the report, and 4 per cent. 1 to 2 years).

The main findings were as follows:

DEATHS.—The stillbirth rate in the series was 20 per thousand total births, and the infant mortality rate 18 per thousand live births.

25 per cent. of the stillbirths, 22 per cent. of the first year deaths, and 29 per cent. of the later deaths were associated with serious malformations.

DEFECTS.—Serious malformations were found in 28 per thousand total births (neurological 12, cardiac 9, genito-urinary 3, hare lip or cleft palate 2, and pyloric stenosis 6 per thousand).

Other and for the most part less serious abnormalities were found in 96 per thousand surviving children (musculo-skeletal defects 14, hernias 26, naevi 10, eye defects 43, and miscellaneous defects 12 per thousand). In addition, 26 per thousand surviving children developed asthma or eczema and 19 per thousand convulsions or fits.

The incidence of abnormality was examined among the children of mothers with particular characteristics or experiences during pregnancy. Associations significant at a 5 per cent. level were observed as follows:

(1) *Employment.*—Of a group of 28 women working full-time in laundries, four had children with serious defects—an incidence of 143 compared with 28 per thousand in all mothers.

(2) *Febrile Illness.*—148 women reported a febrile illness in the first 12 weeks of pregnancy. They had an excess of abortions (47 compared with 21 per thousand) and children with serious defects (61 compared with 28 per thousand), eye defects (68 compared with 35 per thousand), and asthma or eczema (61 compared with 24 per thousand).

(3) *Pulmonary Tuberculosis.*—The 61 women with a history of pulmonary tuberculosis had an excess of children with serious defects (98 compared with 28 per thousand).

Malformations showed no significant association with most of the events recorded in early pregnancy, notably anaemia, vaginal bleeding, vomiting, fainting, injury or operation, anaesthetic, attempted abortion, and severe emotional upsets.

I wish to thank the Medical Officer of Health for Hertfordshire for allowing me to conduct this survey and all the health visitors who took part in it, particularly those who had a large number of children to trace. I am also grateful to many medical officers of health, general practitioners, consultants and mothers who helped me, and the staff of the General Register Office and local registration service and local Executive Councils for their assistance in tracing children.

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Brit. J. prev. soc. Med. (1961), **15**, 167

GEOGRAPHICAL DISTRIBUTION OF PRIMARY TUMOURS OF BONE IN ENGLAND AND WALES

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A study of the reliability of the diagnosis of primary malignant tumour of bone as the cause of death has enabled an estimate to be made of the mortality from bone tumours in England and Wales, by sex and age (Mackenzie, Court Brown, Doll, and Sissons, 1961). The data obtained can be used in conjunction with census data to see whether the mortality from bone tumours varies significantly in different parts of the country. In the present study a comparison is made between the observed and expected mortality in 39 areas, and the variation in the mortality has been compared with the variation in the radioactivity of local water supplies.

METHOD.—The population of each local authority area is known for each sex and 5-year age group at the time of the census in 1951, and estimates of the home populations for both sexes and for all ages combined are known for each of the major areas for the 3 years 1951, 1952, and 1953. The number of bone tumour deaths expected in each area has, therefore, been calculated in three steps. First, the census population in each sex and 5-year age group in each area has been multipled by the ratio between the average population in that group in the whole country throughout the period 1951–53 and the corresponding population recorded at the time of the census. Secondly, the resulting populations in each sex and age group have been multiplied by the corresponding sex and age-specific annual mortality rates, and the results have been summed for all ages under 65 years. Thirdly, the expected numbers of bone tumour deaths so obtained have been corrected for differential rates of population growth by multiplying by the ratio between the total estimated population for each area for 1951–53, and the total population obtained for that area by assuming that the rate of population growth in each sex and age group was equal to that for the whole country. For example, 201,267 boys aged 15–19 years were recorded as living in Greater London at the 1951 census; the ratio between the average population of England and Wales in 1951–53 and the census population for the entire country in this sex and age group was 1·0474, so that the corrected population was 210,807. The corresponding average annual mortality rate from bone tumours in 1951–53 was estimated to be 13·72 per million, so that the number of deaths expected in this sex and age group in Greater London in one year was calculated to be 2·8923. The annual total number of deaths in both sexes and at all ages under 65 years was 37·4931, so that the number expected in a 3-year period was 112·48. Since the correcting factor for the differential rate of population growth in Greater London was 0·9949, the final estimate of the expected number of bone tumour deaths in Greater London was 111·91.

Data were calculated separately for each county and for County Boroughs of more than 700,000 population. The only exceptions were the following:

(1) If the number of expected deaths was less than

four, the county was combined with a neighbour*;

(2) Greater London and the remaining parts of the Home Counties (*i.e.* Kent, Surrey, Hertfordshire, and Essex) were treated as two areas;

(3) Wales, apart from Glamorganshire and Monmouthshire, was treated as a single unit.

RESULTS

GEOGRAPHICAL DISTRIBUTION.—The numbers of deaths observed and expected in each area are shown in Table I.

TABLE I

DEATHS FROM PRIMARY TUMOURS OF BONE IN DIFFERENT PARTS OF ENGLAND AND WALES, 1951–1953

Observed compared with expected

Area	No. of Deaths		Standardized Mortality Ratio
	Observed	Expected	
Manchester	17·40	9·68	180
Norfolk	12·89	7·52	171
Monmouthshire	9·73	5·80	168
Cheshire	27·29	17·24	158
Northumberland	15·33	10·89	141
Leicestershire and Rutland	12·22	8·75	140
Glamorgan	23·04	16·59	139
Sussex	16·85	12·31	137
Cambridgeshire and Huntingdonshire	5·88	4·55	129
Warwickshire, less Birmingham	12·52	10·15	123
Liverpool	13·03	10·69	122
Devon	13·04	10·99	119
Leeds	8·13	6·86	119
Herefordshire and Shropshire	6·91	6·02	115
Lincolnshire	10·94	9·67	113
Sheffield	7·66	6·91	111
Yorkshire, less Sheffield and Leeds	51·84	49·28	105
Cornwall	4·86	4·74	103
Staffordshire	22·36	22·04	101
Lancashire, less Liverpool and Manchester	49·86	49·26	101
Birmingham	14·57	14·82	98
Home Counties*, less Greater London	41·24	42·56	97
Hampshire	17·51	18·23	96
Durham	19·17	20·17	95
Dorset	3·87	4·14	93
Wiltshire	5·37	5·79	93
Wales, less Glamorgan and Monmouth	11·89	13·34	89
Buckinghamshire and Oxfordshire	8·00	9·44	85
Cumberland and Westmorland	4·03	4·81	84
Derbyshire	9·38	11·27	83
Nottinghamshire	9·34	11·51	81
Gloucestershire	10·08	12·80	79
Greater London	82·91	111·91	74
Bedfordshire	3·05	4·40	69
Somerset	4·98	7·35	68
Berkshire	3·00	5·72	52
Worcestershire	3·61	7·18	50
Northamptonshire	2·00	5·74	35
Suffolk	1·63	6·15	27
All Areas	597·41	597·27	100

* Kent, Surrey, Middlesex, Hertfordshire, Essex, and London.

* This was determined independently, without knowledge of the results, so as to avoid bias in the choice of counties to be combined.

It will be noted that in most cases the number of observed deaths is not an integer. This anomaly is due to the fact that the data from which the deaths have been obtained were incomplete (Mackenzie, Court Brown, Doll, and Sissons, 1961). In the 3-year period 1951–53, 1,169 deaths were attributed to primary tumours of the bone among persons aged less than 65 years, who were resident in England and Wales. Inquiries showed that the diagnosis could be confirmed in approximately 52 per cent. Further information beyond that recorded on the death certificate was, however, obtained for only 990 cases, and an estimate had to be made of the number of true bone tumours corresponding to the 179 deaths for which no further information was available. The detailed information obtained for the 990 cases allowed this to be done with considerable confidence. For example, none of the deaths attributed to cancer of the ethmoid proved to be due to a primary bone tumour, whereas the diagnosis was confirmed in 44 out of 45 deaths (98 per cent.) described as occurring in association with Paget's disease. Consequently, it was possible to give a value (between 0·00 and 1·00) for each of the 179 deaths in which no further information was obtained, indicating the probability that the death was due to a primary bone tumour, and these values have been included in the total number of cases observed in each area.

The extent of the variation in mortality between the different areas can be seen by comparing the standardized mortality ratios (that is, the ratios of the observed to the expected deaths, expressed as a percentage). Table I shows that these varied from 27 per cent. in Suffolk to 180 per cent. in Manchester. With the small number of deaths recorded in some of the areas, considerable variation must, however, be expected due to chance factors alone. A test of the significance of the difference between the observed and expected deaths shows that $\chi^2 = 47 \cdot 12$. For 38 degrees of freedom this value has a probability of between 0·3 and 0·4, and it must, therefore, be concluded that the extent of the variation recorded between the different areas is no more than could reasonably be attributed to chance. It does not necessarily follow that there are no local factors which affect the incidence of bone tumours, but only that the effects of any such factors are too small in comparison with the effect of random factors to be detected with the amount of data now available. In fact, examination of the Figure (opposite), in which the data from Table I are presented cartographically, suggests that there may be real regional differences. Several counties with low standardized mortalities are grouped together in the southern and south-midland regions and it is possibly significant that the

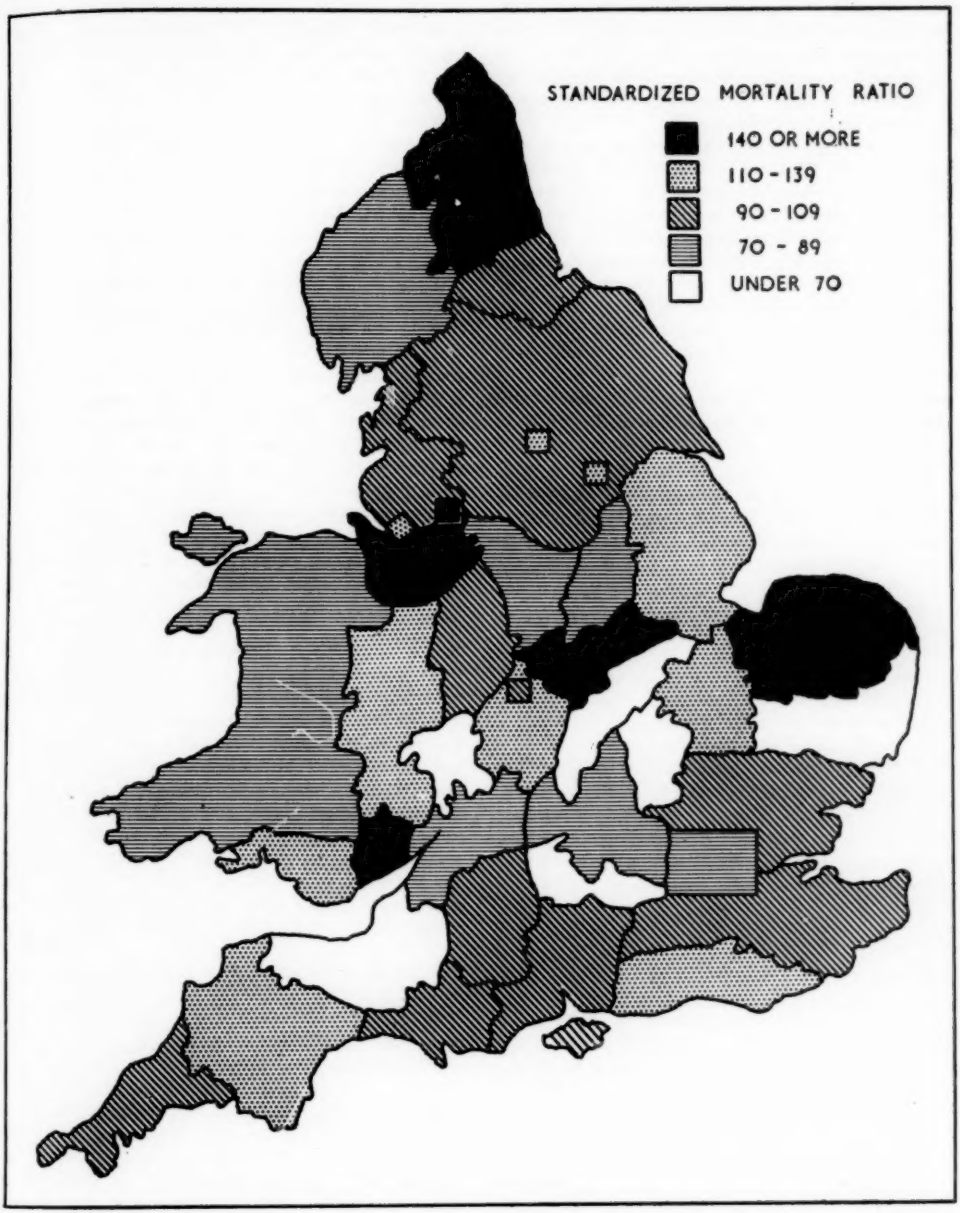

FIGURE.—Map of England and Wales showing standardized mortality ratio for malignant tumours of bone at ages under 65 years, in 39 areas, in 1951–53.

areas with a high mortality include a large proportion of industrialized communities with a relatively low economic status. Whether these groupings are of any significance can be tested by seeing whether they are repeated in other studies of the distribution of the disease at other periods.

RADIOACTIVITY OF WATER.—Drinking water supplies one of the principal sources of ingested radium, and it is of interest to see whether there is any correlation between the radium content of the water and the mortality from bone tumours in different parts of the country. No fully representative data for the radium content of water are available, but Turner, Radley, and Mayneord (1961) have published the results of measurements carried out on 63* samples of water from nineteen of the areas shown in Table I.

Average values of the samples for each of the nineteen areas are shown in Table II, in comparison with the corresponding standardized mortality ratios. There is no obvious correlation between the two sets of data and the correlation coefficient ($r = -0{\cdot}086$; S.E. $0{\cdot}228$) is not significantly different from zero. This does not necessarily mean that the small amounts of naturally-occurring body radioactivity are not responsible for any cases of bone tumour. First, the samples of water may not be properly representative of the areas from which they were taken. Secondly, drinking water is only one source of natural body radium. If the water content is high and the dietary content of α-emitters is low, drinking water may be the most important source. If, however, the diet contains a large proportion of cereals, the relative importance of drinking water may be small. For example, Mayneord (personal communication) has shown that the average α-ray activity of the bones of residents in Cornwall is only about twice that of the bones of Londoners, whereas the difference between the activity of the water supplies shown in Table II is approximately fourfold. It may, however, be noted that the range of the differences in the α-activity of water is large (more than thirty-fold) and the data may be regarded as evidence that the radioactivity of drinking water is not a major factor in the production of primary malignant tumours of bone in Britain.

TABLE II

COMPARISONS BETWEEN STANDARDIZED MORTALITY RATIOS FOR BONE TUMOURS AND LONG-LIVED α-ACTIVITY OF LOCAL DRINKING WATER

Area	Standardized Mortality Ratios (1951–53)	α-Activity of Drinking Water at 30 Days (1960)	
		No. of Samples	Mean Value ($\mu\mu$c./litre)
Somerset	68	1	0·33
Greater London	74	6	0·54
Gloucestershire	79	5	1·20
Buckinghamshire and Oxfordshire	85	2	0·17
Wales, less Glamorgan and Monmouthshire	89	7	0·07
Dorset	93	1	0·11
Hampshire	96	1	0·23
Home Counties, less Greater London	97	3	0·38
Birmingham	98	1	0·07
Staffordshire	101	3	0·91
Cornwall	103	10	2·23
Yorkshire, less Leeds and Sheffield	105	2	0·41
Sheffield	111	1	0·09
Lincolnshire	113	1	1·34
Devon	119	3	0·34
Warwickshire, less Birmingham	123	1	1·60
Sussex	137	1	0·11
Glamorgan	139	2	0·36
Manchester	180	3	0·07

* Excluding the data for spa water, but including the figures for Sampford Spinny given in the addendum.

SUMMARY

A comparison has been made of the observed and expected mortality from true primary tumours of the bone in 39 parts of England and Wales in 1951–53. The results show that there was a zone of relatively low mortality in the southern and south-midland parts of the country, but that the variation in mortality throughout the country was no more than could reasonably be attributed to chance.

The standardized mortality ratio was not significantly correlated with published figures for the long-term radioactivity of drinking water in nineteen of the areas.

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Brit. J. prev. soc. Med. (1961), **15**, 171

SOCIAL CLASS MIGRATION AND CHRONIC BRONCHITIS*

A STUDY OF MALE HOSPITAL PATIENTS IN THE LONDON AREA

BY

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In England and Wales the standardized mortality ratios for bronchitis of both men and married women show a gradient from Social Class I to V, which is among the steepest found for any disease. Table I shows that this has been consistent since figures were first published (Registrar General, 1923, 1927, 1938, 1958a).

TABLE I

STANDARDIZED MORTALITY RATIOS FOR BRONCHITIS

Patients		Time Period (yrs)	Social Class				
Sex	Age (yrs)		I	II	III	IV	V
Males	20–64	1910–12	41	68	95	98	184
		1921–23	26	55	94	121	177
		1930–32	31	57	91	124	156
		1949–53	34	53	98	101	171
Married Women	20–64	1930–32	27	56	99	119	155
		1949–53	35	49	101	123	154

Morbidity studies by Logan (1960) have also shown a similar, though less steep, social class gradient.

These class differences are generally thought to be due to adverse factors associated with life in the lower social classes (Registrar General, 1938, 1958b; Vernon, 1939; Goodman, Lane, and Rampling 1953; Pemberton, 1953; Lane, 1954; Fletcher, 1956; Stuart-Harris and Hanley, 1957).

It is also possible that a drift down the social class scale of those disabled by bronchitis might contribute to the gradient in men, particularly the excess in Social Class V. A pilot inquiry by Public Health students at the London School of Hygiene and Tropical Medicine supported this hypothesis and encouraged the study described in this paper.

METHOD

The effect that chronic bronchitis may have on a man's choice of job, and therefore on his social class, will be most apparent when the disease is advanced. For this reason hospital patients were chosen since they are a readily accessible group with advanced bronchitis. Changes in social class were studied by taking occupational histories; these were compared with the histories of patients with other diseases. This method of using hospital patients for epidemiological inquiries is similar to that exploited by Doll and Bradford Hill (1950) and other investigators in studies of lung cancer.

Six large hospitals in the London area were used for this inquiry, which was made during the first three months of 1960. All male patients aged 45 to 64 years with a diagnosis of chronic bronchitis were interviewed. In answer to standard questions, each of them had persistent cough and phlegm and had had one or more chest illnesses in the past 3 years. Thus they all came within the definitions of bronchitis used both by Higgins, Oldham, Cochrane, and Gilson (1956) and by Fletcher, Elmes, Fairbairn, and Wood (1959). No attempt was made to estimate a date of onset of the disease but the majority of the patients had a history of chest symptoms extending over many years. One-third of them had not worked for over 6 months; some had definitely retired on account of their bronchitis; others were hoping to return to work. After excluding those who had additional diagnoses, such as tuberculosis or bronchiectasis, 111 patients were left for further study.

Patients of the same age, and from the same wards, were interviewed as controls, those who had previously been in hospital with bronchitis being excluded.

* Based on a paper given to the Society for Social Medicine at Oxford on September 30th, 1960.

A broad classification of the diagnoses of this control group is given in Table II.

TABLE II
DIAGNOSES OF CONTROLS

Diagnosis	Number of Cases
Cardiovascular Disease:	
Coronary	23
Other	22
Gastrointestinal Disease	21
Pulmonary Disease (excluding Bronchitis)	21
Miscellaneous	24
Total	111

The case and control patients were of similar ages, a majority being in the older age groups (Table III).

TABLE III
AGE DISTRIBUTION OF BRONCHITICS AND CONTROLS

Age (yrs)	Bronchitics	Controls
45–	6	6
50–	17	17
55–	43	43
60–64	45	45
All Ages	111	111

There was little difference in the residential areas of the cases and controls but there were interesting differences in smoking habits; 10 years ago the patients with bronchitis were smoking more than the control patients, but at the time of interview they were smoking less and a greater proportion of them had given up smoking altogether.

In taking the occupational histories, an entry was made of the jobs done by each patient since leaving school. The main occupation of the father while the patient was at school was also recorded. A simplified version of an occupational history is given in the Figure (opposite).

The occupations were classified by social class (General Register Office, 1956a). The patients were then assigned to one of these social classes for each 5-year period of their working lives, starting backwards from the time of interview. If a patient had held jobs of differing social class during any 5-year period he was given the grading of the job (or jobs) held for the longest time during the period.

RESULTS

The changes in the social class of the controls and of the patients with bronchitis are given in Tables IV and V. There is little movement from class to class for the control patients.

TABLE IV
SOCIAL CLASS DISTRIBUTION OF CONTROL PATIENTS AGED 45–64 YEARS

Social Class	(a) Childhood*	(b) Working Life (Years Ago)					
		24–20	19–15	14–10	9–5	4–0	Now
I and II	21	20	19	25	26	25	23
III	59	64	71	61	60	61	62
IV	16	10	6	12	10	12	13
V	13	17	15	13	15	13	13
Unknown	2	—	—	—	—	—	—
Total	111	111	111	111	111	111	111

* Based on father's occupation.

TABLE V
SOCIAL CLASS DISTRIBUTION OF BRONCHITIC PATIENTS AGED 45–64 YEARS

Social Class	(a) Childhood*	(b) Working Life (Years Ago)					
		24–20	19–15	14–10	9–5	4–0	Now
I and II	15	2	3	5	5	4	4
III	60	67	69	60	60	51	48
IV	21	17	20	21	22	23	24
V	12	25	19	25	24	33	35
Unknown	3	—	—	—	—	—	—
Total	111	111	111	111	111	111	111

* Based on father's occupation.

The apparent lack of movement among the control patients might have been due to those in a particular disease group, for example, coronary artery disease, moving up in social class while those in another moved down. This possibility was investigated by analysing each disease group separately; no significant change, up or down, was found in any of them.

On the other hand, there is considerable downward movement of the patients with bronchitis. This showed up in the last 5-year period and occurred principally in the older patients.

There was a slight increase in Social Class III for both groups of patients 19 to 15 years ago, that is, during the second world war: this is due to a rise in the number who served in the armed forces. All "other ranks" are allocated to Social Class III irrespective of social class at the time of call-up (General Register Office, 1956a).

The social class of a child was based on the main occupation of the father while the child was at school and may be taken as an index of early social

A SIMPLIFIED EXAMPLE OF AN OCCUPATIONAL HISTORY (UP TO AGE 57)

AGE	YEAR	JOB	INDUSTRY	OCCUPATION CODE	SOCIAL CLASS	YEARS AGO (CLASS)
0	1903					
Childhood		Engine Driver (Father's occupation while patient at school)	Railway	631	III	
14	1917	Boy	Glass Works	936	V	
		Wooden Box Maker	Wood Works	475	IV	
21	1924	Batch Mixer	Glass Works	079	III	
36	1939					24–20 (III)
						19–15 (III)
		Car Park Attendant	Car Park Contractors	669	IV	14–10 (III)
		Wooden Box Maker	Cycle Manufacturer	475	IV	
		Packer	Engineering Firm	909	IV	9–5 (IV)
		Cleaner (Sweeping Up)	Food Factory	876	V	
57	1960					4–0 (V) (Now V)

background. During this period there was an overall similarity in the social class distribution of the two groups of patients with a slight excess in Social Class IV and a deficiency in Social Classes I and II for the patients with bronchitis.

The social class distribution of those with bronchitis, 24 to 20 years ago, shows a drop in social class when compared with that of childhood (Table V). The control patients do not show the same drop between these two periods of time. This means that there are more bronchitic than control patients in the lower social classes in the earlier periods and that, as a group, those with bronchitis have had less opportunity for downward movement in recent years. If a uniform age (say, age 30 years) is substituted for the time period 24 to 20 years ago, similar differences are apparent.

Discussion and Conclusions

There are economic and social factors unassociated with illness which influence social class movement. For example, technical advance is an important cause of the decreasing proportion of men in Social Classes IV and V reported in the 1951 Census (General Register Office, 1956b). At the same time the need for more technical knowledge and the speeding up of industrial processes may, in part,

explain the finding of Stein (1959) that the proportion of men in the lower social classes increases between the ages of 45 and 64 years. There is, however, no reason to believe that these factors have had very different influences on the two groups of patients in this study.

It has been shown that there was an increase in the number of bronchitic patients in the lower social classes, and that this occurred principally during the 5 years immediately before the interview in hospital. Since the control patients remained practically stable during this time it is likely that the job changes which accounted for this increase were caused by periods of sickness and increasing disability.

Hospital patients have been shown to differ from the total population in certain social characteristics (Registrar General, 1954; Abel-Smith and Titmuss, 1956). It is therefore probable that patients in hospital with bronchitis are not representative of all bronchitics and might undergo a different pattern of social class migration. However, it is suggested that a majority of men certified as dying of bronchitis before age 65 will have been in hospital with the disease at some time. Therefore the patients studied may not differ substantially from those on whom the Registrar General calculates the standardized mortality ratios for bronchitis.

It is also possible that, though at an advanced stage of their illness, some of those interviewed might on leaving hospital take on new jobs in different social classes. Thus the full extent of the changes in social class between the onset of chronic bronchitis and death may not have been recorded. Furthermore, the numbers of patients studied in some social classes are small.

For these reasons, though the data does support the original hypothesis, that bronchitics drift down the social class scale, no reliance can be placed on a quantitative estimate of the extent of the drift. The method by which such an estimate could be made is, however, given in the Appendix.

Though married women were not included in this study, their excess mortality in Social Class V cannot be due to this migration factor, as their social class is based, not on their own but, on their husband's occupation.

The drop in social class of the bronchitic patients between childhood and adult life is more difficult to explain. Despite the finding of Reid and Fairbairn (1958) that those who retired from the Post Office on account of bronchitis had had an excess of sickness absence from chest illnesses from the age of 15 years onwards, it is unlikely that the disease will have caused changes in social class at this stage. The small group of younger bronchitics show virtually no drift down the social class scale. Furthermore, analysis of the older age group, going further back in time reveals little movement in earlier working life. It may be that there are factors in the make-up of a man which prevent his attaining the social class of his father which are also related to the development of bronchitis. Such factors were not considered in this study. The extent to which a man's personality and his social and occupational environment each contribute to the steep social class gradient can be more clearly defined only by a detailed epidemiological study outside the hospital.

This study as a whole does, however, illustrate the effect that chronic disease has on the work that a man can do during his lifetime, an effect which should not be overlooked when using mortality or morbidity data to study relationships between environment and chronic disease.

Summary

Occupational histories were taken from 111 male hospital in-patients with chronic bronchitis and an equal number of control patients. The social class of each subject, in 5-year periods throughout his working life, was obtained from these histories. The bronchitic patients showed a drift down the social class scale, principally in the last 5 years before the interview in hospital, compared with the control patients. This change in social class was brought about by changes in occupation which were probably due to sickness absence and increasing disability. Similar changes may account for some of the excess mortality from bronchitis in Social Class V. The difficulties in calculating the extent of this drift are described. It also appeared that fewer bronchitic than control patients attained the social class of their fathers even in the first half of their working lives.

The pilot inquiry by Public Health students was of value in planning this study. Thanks are due to them and particularly to Dr. I. McIntosh. I am most grateful to the physicians of the Central Middlesex, Pinewood, St. Charles, St. Stephens, and Whittington Hospitals, and of Harefield Sanatorium for permission to interview their patients and to have access to hospital notes, and to all others in these hospitals who made this study possible. I should like to thank Prof. R. S. F. Schilling and Dr. C. H. Wood for their help and encouragement, Mrs. M. Jeffreys and Dr. L. Stein for helpful comments, and Dr. P. Armitage for statistical advice on the calculation given in the Appendix. The author was in receipt of a grant from the North-West Regional Hospital Board during the period of this study.

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APPENDIX

Method of Calculating a Correction Factor for Social Class Migration

(Factors influencing the validity of this calculation are described in the text)

The ratios of bronchitic and control subjects in each social class at the time of interview compared with 9 to 5 years ago is shown in Table VI.

TABLE VI

CALCULATION OF A CORRECTION FACTOR FOR SOCIAL CLASS MIGRATION

Social Class	Bronchitics			Controls			Ratio of (c_1) to (c_2)
	Time Period		Ratio of (a_1) to (b_1)	Time Period		Ratio of (a_2) to (b_2)	
	9–5 yrs ago (a_1)	Now (b_1)	(c_1)	9–5 yrs ago (a_2)	Now (b_2)	(c_2)	
I	1	1	*1·00*	3	3	*1·00*	*1·00*
II	4	3	*1·33*	23	20	*1·15*	*1·16*
III	60	48	1·25	60	62	0·97	1·29
IV	22	24	0·92	10	13	*0·77*	*1·19*
V	24	35	0·69	15	13	1·15	0·59

Ratios based on numbers of ten or less are shown in italics.

By applying the ratio for bronchitics, c_1, to the Registrar General's standardized mortality ratios for bronchitis, an estimate is obtained of the social class distribution that would have prevailed among bronchitics at the time of death had there been *no change in social class after the development of the disease* (Table VII, Col. A).

TABLE VII

REGISTRAR GENERAL'S STANDARDIZED MORTALITY RATIOS FOR BRONCHITIS CORRECTED FOR CHANGES IN SOCIAL CLASS ASSOCIATED WITH THE DEVELOPMENT OF THE DISEASE

Social Class	S.M.R.	A		B	
		Ratio (c_1)	S.M.R. Corrected by Ratio (c_1)	Ratio (c_1) to (c_2)	S.M.R. Corrected by Ratio (c_1) to (c_2)
I	34	*1·00*	34·00	*1·00*	*34·00*
II	53	*1·33*	70·49	*1·16*	*61·48*
III	98	1·25	122·50	1·29	126·42
IV	101	0·92	92·92	*1·19*	*120·19*
V	171	0·69	117·99	0·59	100·89

Ratios based on numbers of ten or less are shown in italics.

However, allowance must be made for the changes in social class that take place in the whole population

in order to show what proportion of the changes occurring in the bronchitics is specifically associated with the development of the disease rather than to the general factors described in the text.

By applying a correction ratio, $\frac{c_1}{c_2}$, expressing the differential migration of bronchitics and controls, to the Registrar General's standardized mortality ratios for bronchitis, an estimate is obtained of the social class distribution that would have prevailed among bronchitics at the time of death had there been *no excess migration associated with the disease after its development* (Table VII, Col. B).

It must be noted that hospital patients used as controls may differ, in their social class migration, from the whole population to a greater extent than hospital bronchitics differ from all bronchitics. Thus this final adjustment to the correction ratio introduces a further error not discussed in the text.

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PREVALENCE OF NEUROSIS IN WOMEN

BY

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Every survey of the prevalence of neurosis in general practice records a rate in women almost double that in men. This investigation is an attempt to examine a possible cause for this disparity.

The patients studied in this survey constituted a rural general practice of 3,000. Data were collected from the general practitioner's disease index, the patient's record card, and the personal knowledge of the general practitioner, who had made the psychiatric diagnosis. Children under 15, schizophrenics, subnormals, and patients with organic psychoses were excluded. Temporary emotional upsets which subsided rapidly after a single consultation were noted but are not considered in this paper as contributing significantly to psychiatric morbidity and sickness absence. The diagnoses remaining comprised mainly neurotic and depressive reactions, and from these an attempt was made to assess the effects of gainful employment on the prevalence of neurosis in women.

* This investigation was carried out during the "elective period", in which students at the Sheffield Medical School can carry out studies of their own choice.

RESULTS

TEMPORARY EMOTIONAL UPSETS (Table I).—Although there is no material difference in the prevalence of temporary emotional upsets between employed and not employed women, there is a marked decrease in their prevalence in men.

ANXIETY AND DEPRESSIVE REACTIONS.—Table I, showing the effect of employment, seems to indicate that to some extent employment is associated with a lower prevalence of neurosis in women.

TABLE I

PSYCHIATRIC ILLNESS AND EMPLOYMENT

Diagnosis	Men		Women					
			Gainfully Employed		Not Gainfully Employed		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Anxiety and Depressive Reactions	35	2·8	9	3·9	71	8·1	80	7·3
Temporary Emotional Upsets	26	2·1	18	7·8	53	6·1	71	6·4
No Psychiatric Disorder	1,171	95·1	204	88·3	747	85·8	951	86·3
Totals	1,232	100·0	231	100·0	871	100·0	1,102	100·0

At this point, however, it is necessary to take into account the effects of age and civil status. Women over 60 are very rarely employed, yet contribute greatly to psychiatric morbidity rates. As only married women are likely to be able to choose whether to take up employment or not, single women were excluded.

Table II shows that the association between increased rate of psychiatric illness and lack of outside employment shown in Table I is not confirmed when older age groups are excluded. A more detailed breakdown into age groups did not disturb this pattern. As recorded by other workers, the preponderance of women occurs in all age groups.

TABLE II
PSYCHIATRIC ILLNESS IN MEN AND WOMEN UNDER 60 YEARS

Diagnosis	Married Women				Men	
	Employed		Not Employed		Employed	
	No.	Per cent.	No.	Per cent.	No.	Per cent.
Anxiety and Depressive Reactions ..	8	9·4	40	6·9	25	2·6
No Psychiatric Disorder	58	90·6	537	93·1	936	97·4
Totals	66	100·0	577	100·0	961	100·0

Table III shows an association between widowed and married women and a higher rate of psychiatric disorder. Unfortunately the data did not provide an age breakdown of patients without psychiatric disorder in these different civil status groups, so that the probability of the effect on age still has to be borne in mind, in that the majority of single women belong to younger age groups with a low incidence of psychiatric disorder.

DISCUSSION

Although a high female/male ratio is noted in all prevalence studies of psychiatric disorder, as far as the writers are aware there have been no published attempts to isolate possible factors relevant to this finding. Logan and Cushion (1958) showed that this ratio did not hold for all disease groups and Stein (1960) was able to show that the number of consultations in women was unrelated to marital state, number of children, or employment, which suggests that the housewife does not visit the doctor more frequently merely because she has more opportunity.

A period prevalence study such as this is not the most refined tool in epidemiological investigations, and it is felt that an inception study of psychiatric disorder amongst women both employed and not employed is necessary before the effect of occupation can be ruled out. Brown, Carstairs, and Topping (1958) have already shown the beneficial effect of occupation in chronic schizophrenia, so it is not unreasonable to suppose that it would have a similar stabilizing effect in women. It has also been shown that prolonged unemployment in men can lead to psychological disturbance (Morton, 1935; Eisenberg

TABLE III
PSYCHIATRIC ILLNESS AND CIVIL STATUS OF WOMEN

Diagnosis	Civil Status							
	Single		Married		Widowed		Total	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Anxiety and Depressive Reactions	5	2·5	71	8·2	4	10·0	80	7·3
Temporary Emotional Upsets	13	6·6	55	6·4	3	7·5	71	6·4
No Psychiatric Disorder	179	90·9	739	85·4	33	82·5	951	86·3
Totals	197	100·0	865	100·0	40	100·0	1,102	100·0

and Lazarsfeld, 1938). It is not perhaps justifiable to compare the subjects of these studies with the contemporary housewife, but a recent commentator (*Lancet*, 1960) points out that, when the children are at school and the housework is reduced to a minimum by modern appliances, "she is likely to question her own reason for existence and to feel a vague but pervasive dissatisfaction". This is clearly fertile soil for neurosis.

It must also be remembered that the social consequences of employment are not confined to providing occupation. The additional income may relieve financial worry, increase self esteem, and perhaps alter the status of the employed woman with her husband, family, and friends. A recent Sheffield investigation (Hodges and Smith, 1954) has shown that employed women have more friends than those who are solely housewives. These changes in the social environment are not irrelevant to the production of neurosis, and are among the factors which are so often uncontrolled in epidemiological studies. On the other hand, as well as these social and economic benefits of occupation, the presence of neurotic symptoms may itself be a powerful motivation for a woman to seek employment outside her house, spurred on by the advice of her friends and the popular weeklies. It is this possibility which makes an inception study of more value than a prevalence study; many of the married neurotic women may have sought employment to alleviate their symptoms.

What does seem to be beyond dispute is the greater instability of the female psychological adjustment, and this is well shown by Table I. The trials of the female reproductive system are confidently blamed for this well-recognized fact, but Logan and Cushion (1958) do not show any drop in psychiatric morbidity in the post-menopausal years, and this is in accord with the experience of this practice. It may well be that the female reproductive system is not so grave a psychological hazard as are the attitudes and expectations imposed by our society on those who possess it.

Summary

(1) In a survey of psychiatric morbidity in a rural general practice of 3,000 patients, the increased prevalence in women is confirmed.

(2) Gainful occupation outside the home is not associated with any decrease in prevalence in women.

(3) It is suggested that the increased prevalence in women of psychiatric illness may be due to social and cultural factors which have yet to be identified.

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Brit. J. prev. soc. Med. (1960), **15**, 180

AN ANALYSIS OF TETANUS PROPHYLAXIS IN 3,455 CASES

BY

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The patients included in this investigation attended the Leeds Public Dispensary between June, 1958, and March, 1959. The objectives of this series are (1) to ascertain the immunity status to tetanus of these patients, (2) to determine the age and sex distribution, (3) to evaluate the sensitivity to anti-tetanus serum, and (4) to assess the significance of test dose reactions and of local reactions in relation to general reactions occurring later.

Indications for prophylaxis were taken as those enumerated by Gissane and Lowbury of the Birmingham Accident Hospital: *i.e.* wounds more than 3 hours old, already infected, contaminated with soil and manure, deep and punctured wounds, however small, wounds with devitalized tissues, and wounds that could not be closed properly and might therefore be infected later.

Method of Investigation and Prophylaxis

Each patient requiring prophylaxis was interrogated regarding previous serum injections, asthma, infantile eczema, previous anti-tetanus serum reaction, and previous tetanus toxoid injections. It was accepted that previous serum injection had been given if the patient had been told the injection was anti-tetanus serum against lockjaw, or had received two injections at hospital after cuts or wounds with a half-hour interval between the injections; this was confirmed by records whenever possible. Previous tetanus toxoid injections were recorded if the patient knew that he had been given tetanus toxoid or had been in the Services—excluding the years 1945 to September, 1949, in the British Army, or 1945 to 1958, in the Royal Navy, when tetanus toxoid usage was temporarily abandoned. The Royal Air Force has continued tetanus toxoid administration without a break since 1939. On this information it was decided whether to give anti-tetanus serum or tetanus toxoid. If the patient had been immunized with tetanus toxoid at any time after 1939, a booster dose of tetanus toxoid was given, otherwise 0·9 ml. anti-tetanus serum was given intramuscularly half an hour after a test dose of 0·1 ml. subcutaneously.

If the patient had suffered with asthma, infantile eczema, or previous anti-tetanus serum reaction, but required anti-tetanus serum, this was given by the multiple dose method—0·1 ml. of a 1 in 10 dilution of anti-tetanus serum subcutaneously, followed at half-hourly intervals by 0·1 ml. undiluted serum subcutaneously, 0·1 ml. intramuscularly, and finally 0·8 ml. intramuscularly.

A record of these facts was made and the patient was given a slip of paper with the following instructions:

> "Please return to the Casualty Department if you have itching, skin rash, swelling, or redness at the place where the injection was given."

This was done in order to reduce missed reactions to a minimum.

If a reaction occurred, details were recorded and the reaction classified as anaphylaxis, local reaction, serum sickness, Arthus phenomena, thermal, or neurological, and the patient was asked to return after 6 weeks for an initial tetanus toxoid immunization.

Results

3,455 patients received prophylaxis, the indications being those detailed above; 2,726 (79 per cent.) were given anti-tetanus serum and 729 (21 per cent.) tetanus toxoid.

In all cases, except one of anaphylaxis to the test dose and seventeen of immediate local reaction, the full dose of anti-tetanus serum was given. If a patient developed a local reaction to the test dose before receiving the full dose of anti-tetanus serum, oral

antihistamines were given and then he was given the full dose of anti-tetanus serum half an hour later (except the eighteen patients listed above to whom antihistamines alone were given). Antihistamines were then continued for 3 days.

Only patients who had received previous active immunization were given tetanus toxoid. Four of the 733 patients who thought they had been previously immunized with tetanus toxoid before September 3, 1939, were given anti-tetanus serum in view of the doubt about the previous injections and the time interval, which was considered too long. The distribution of these intervals is shown in Table I; in 58 per cent. the interval was over 10 years.

TABLE I

INTERVAL SINCE LAST INJECTION IN PATIENTS PREVIOUSLY IMMUNIZED WITH TETANUS TOXOID

Interval (yrs)	Number of Patients
0–4	164
5–9	143
10–14	214
15–19	208
20–25	4
Total	733

The age and sex distribution of patients given each prophylactic are shown in Table II. Thus, 49 per cent. of the patients requiring prophylaxis were under 20 years of age, and of these only 0·93 per cent. had previously been inoculated with tetanus toxoid. A large proportion of the male patients aged 20–49 years were ex-service men, and in this group toxoid was used more frequently than serum. In older men, and in women of all ages, serum was the commoner prophylactic required. Up to the age of 30 years males required prophylaxis approximately three times as frequently as females; beyond 50 years of age about equal numbers of men and women were treated.

TABLE II

NUMBER OF PATIENTS GIVEN ANTI-TETANUS SERUM AND TETANUS TOXOID, BY AGE AND SEX

Age (yrs)	Anti-tetanus Serum			Tetanus Toxoid		
	Males	Females	Both Sexes	Males	Females	Both Sexes
0– 9	578	266	844	6	2	8
10–19	634	222	856	8	—	8
20–29	198	82	280	268	3	271
30–39	137	80	217	256	1	257
40–49	130	82	212	145	—	145
50–59	107	91	198	37	—	37
60–69	52	45	97	3	—	3
70–79	10	10	20	—	—	—
80–89	1	1	2	—	—	—
All Ages	1,847	879	2,726	723	6	729

Three patients returned of their own accord with a reaction at the site of the tetanus toxoid injection. The incidence may have been greater than this as patients receiving tetanus toxoid were not given instructions to return if symptoms developed.

The number of patients who reported to the Dispensary with reactions to anti-tetanus serum is shown in Table III. Local reactions were reported by 6·2 per cent. of males and 12·9 per cent. of females. General reactions, however, were equally frequent in both sexes, and were reported by 1 per cent. of patients. The age of the patients seemed to have little effect on the frequency of reporting reactions. Of the 27 patients with general reactions, two had severe anaphylaxis, one 30 mins. after the test dose, and the other 50 mins. after the test dose and 20 mins. after the full dose. The remaining 25 patients had serum sickness.

TABLE III

INCIDENCE OF REACTIONS TO ANTI-TETANUS SERUM BY AGE AND SEX

Age (yrs)	Males					Females				
	No. Injected	Local Reactions		General Reactions		No. Injected	Local Reactions		General Reactions	
		No.	Per cent.	No.	Per cent.		No.	Per cent.	No.	Per cent.
0– 9	578	30	5·2	2	0·3	266	26	9·8	1	0·4
10–19	634	40	6·5	2	0·3	222	28	12·6	1	0·5
20–39	335	31	9·3	9	2·7	162	32	19·8	5	3·1
40–59	237	10	4·2	5	2·1	173	20	11·6	2	1·2
60+	63	2	3·2	—	—	56	7	12·5	—	—
All Ages	1,847	113	6·2	18	1·0	879	113	12·9	9	1·0

Table IV shows that a history of a predisposing factor seems to have little influence on the occurrence of local reactions and possibly on general reactions. The numbers are too small for each separate predisposing factor to suggest that any of them separately carries an unusual risk.

TABLE IV

INCIDENCE OF REACTIONS FOLLOWING ANTI-TETANUS SERUM IN RELATION TO PREDISPOSING FACTORS

Predisposing Factor	No. of Patients	Reactions			
		Local		General	
		No.	Per cent.	No.	Per cent.
Previous Anti-tetanus Serum	534	49	9·2	7	1·3
Reaction to Previous Anti-tetanus Serum	10*	4	40·0	0	0·0
Asthma	33	5	15·2	1	3·0
Infantile Eczema	14	3	21·4	1	7·1
All Predisposing Factors ..	572†	57	10·0	9	1·6
No Predisposing Factor ..	2,154	169	7·8	18	0·8
Total	2,726	226	8·3	27	1·0

* Included in "Previous Anti-tetanus Serum" group.
† As some patients exhibited more than one factor this total is less than the sum of the separate groups.

In compiling this Table account was taken of the following observations:

(*a*) Sixteen patients in this series had suffered previous reactions after anti-tetanus serum. Of these, six had subsequently been immunized with tetanus toxoid and were therefore given tetanus toxoid when prophylaxis was required. The other ten patients were given anti-tetanus serum and these ten patients are included in the 534 patients having received previous anti-tetanus serum. Four of these ten patients having had a previous reaction to anti-tetanus serum and being given further anti-tetanus serum developed reactions, and these reactions are included with the 49 patients who had had reactions to previous anti-tetanus serum.

(*b*) Nine patients appeared in more than one category: six of them had had previous anti-tetanus serum and asthma, two had had asthma and infantile eczema, and one had had previous anti-tetanus serum and infantile eczema.

None of these nine patients had reactions.

Thus, the number of patients with one or more predisposing factors is less than the total of the separate predisposing factors.

The timing of reactions is shown in Table V; 50 per cent. of local reactions occurred within 24 hrs of the test dose and the majority of the remainder on the 5th to 8th day. For general reactions the maximum incidence was on the 7th and 8th day. These findings are comparable with the results of other series.

TABLE V

TIME OF ONSET OF REACTIONS TO ANTI-TETANUS SERUM

Interval from Injection	Reactions	
	Local	General
Less than 1 hr	73	2
1–24 hrs	29	3
1– 2 days	24	0
3– 4 days	7	1
5– 6 days	49	7
7– 8 days	28	12
10–11 days	12	2
12 days and Over	4	0
All Intervals	226	27

The relationship of general to local reactions to anti-tetanus serum is illustrated in Table VI. Only a small proportion (5·8 per cent.) of patients with local reactions subsequently developed general reactions. Nevertheless, the occurrence of a general reaction was about ten times as frequent in this group than in those with no local reaction (0·6 per cent.).

TABLE VI

RELATIONSHIP OF LOCAL REACTION TO ANTI-TETANUS SERUM TO THE OCCURRENCE OF A SUBSEQUENT GENERAL REACTION

Local Reaction	Total No. of Patients	No. of These with General Reaction	Proportion with General Reaction (per cent.)
Present ..	226	13	5·8
Absent ..	2,500	14	0·6

The timing of the local reaction seemed to make little difference to the risk of developing a general reaction subsequently; there were two general reactions in the 65 patients in whom the local reaction developed within 30 mins. of the test dose, one general reaction in the eight patients in whom the local reaction developed within 30 to 60 mins. after the test dose, and ten general reactions in the 153 patients in whom the local reaction occurred more than 1 hour after the test dose.

Thirteen (48 per cent.) of the 27 patients who developed a general reaction had a local reaction first. The timing of the local and general reactions for these thirteen patients is shown in Table VII (opposite).

TABLE VII

TIME RELATIONSHIP OF LOCAL REACTION TO SUBSEQUENT GENERAL REACTION

Sex	Age (yrs)	Onset of Local Reaction	Onset of General Reaction	Predisposing Factor
F	45	2nd day	6th day	
F	26	8th day	4 hrs later	
M	20	8th day	8 hrs later	
M	7	6th day	8 hrs later	Previous serum
M	17	40 min.	50 min.	
M	37	30 min.	1 day; recurred at 8th day	Previous serum
M	50	7th day	6 hrs later	
F	2	30 min.	6th day	
M	27	7th day	8th day	
M	45	8th day	2 hrs later	
F	28	8th day	8 hrs later	
M	57	9th day	8 hrs later	Previous serum
F	24	10th day	11th day	Infantile eczema

Table VIII shows the effect of time of year on the incidence of reactions. Although this investigation extended over only 9 months, the incidence was slightly higher in the autumn, which agrees with results obtained in other series.

TABLE VIII

EFFECT OF TIME OF YEAR ON REACTIONS

3-mth Period	Total Anti-tetanus Serum Injections	No. of Local Re-actions	No. of General Re-actions	Per cent. Local Re-actions	Per cent. General Re-actions
June–Aug.	1,104	80	10	7·2	0·9
Sept.–Nov.	647	71	8	11·0	1·2
Dec.–Feb.	975	75	9	7·8	0·9
Total ..	2,726	226	27	8·3	1·0

The incidence of reactions for three large batches of serum (Table IX) revealed little difference between them.

TABLE IX

EFFECT OF BATCH OF ANTI-TETANUS SERUM (THREE LARGEST BATCHES)

Batch	No. of Patients	Local Reaction		General Reaction	
		No.	Per cent.	No.	Per cent.
A	590	57	9·7	7	1·2
B	410	29	7·1	4	1·0
C	406	38	9·3	4	1·0

DISCUSSION

(1) TYPES OF PROPHYLAXIS

The administration of tetanus toxoid at the time of injury is based on American experience. This was the procedure adopted by the American Forces during the second world war, whereas the British procedure was to give anti-tetanus serum at the time of injury even though previous inoculation with tetanus toxoid had been carried out. Long and Sartwell (1947) recorded twelve cases of tetanus in the U.S. Army, of which only one patient had received active immunization, whereas Boyd (1946) recorded 103 cases of tetanus in the British Services during the Second World War. Peterson, Christie, and Williams (1955) have performed tests on the anti-tetanus serum unit levels (A.T.U.) after booster doses of tetanus toxoid at varying intervals of time after the primary inoculation or previous booster injection. Their results indicate persisting antibody levels at low titre up to 10 or 11 years after the primary inoculation, and there was an adequate recall to high titre with a booster dose. In 63 cases tested 9 or more years after the previous tetanus toxoid injection, the levels before the injection of the booster dose were more than 0·01 A.T.U. in all except two. After a booster injection of tetanus toxoid all except two cases had antibody levels higher than 0·1 A.T.U. in 6 or 7 days. 0·1 A.T.U. is generally regarded as an adequate preventive level. However, Descombey and Ramon (1927) regard 0·01 A.T.U. as protective in a person with a basic immunity after a booster dose. 14 days after the booster dose all 63 cases had levels greater than 1 A.T.U. Turner, Stafford, and Goldman (1954) have shown that most individuals who have been actively immunized retain a measurable level of tetanus antitoxin in their sera for at least 11 years, and that these individuals all respond actively and rapidly to a booster injection of toxoid. It is probable that recall may be possible after 20 years or even more.

The usual incubation period of tetanus is 7 to 14 days, but it has been recorded after as little as 24 hours or as much as 3½ months. As few cases occur before the 7th day and as by this time an adequate protective level can be ensured by a booster dose after previous inoculation, this will be sufficient to give protection in the majority of cases. However, in cases of very rapid onset of cephalic tetanus, it has been suggested that the rate of recall may occasionally be too slow unless there is a high basic protective level.

Tetanus may follow the most minor injuries. Press (1948) analysed 982 cases of tetanus in the United States and showed that 15 per cent. followed a trivial injury, and that in 34·5 per cent. the cause and nature of the injury was unknown. Cole (1951) had suggested that many patients probably had injuries so trivial that they had not even been seen

by a doctor. Stafford, Turner, and Goldman (1954) reviewed 169 cases and noted that most of these patients had had what they regarded as trivial injuries for which they did not seek medical attention. The need for a basic protective immunity in these people hardly requires to be emphasized as they are unlikely to receive prophylactic anti-tetanus serum.

When these facts are considered together with Tables I and II, it is obvious that there are many ex-service males in Great Britain who require a booster dose of tetanus toxoid in order to maintain an adequate basic immunity. 21 per cent. of the patients in this series who required tetanus prophylaxis had previously been immunized with tetanus toxoid. The majority of these males of working age, many of whom are exposed to the dangers of tetanus, are in urgent need, especially when 10 years or more have elapsed since the previous tetanus toxoid injection. It is a pity to allow this ex-service group, the only section of the community which has been afforded the ideal active immunity, to lose this form of protection.

Every year since 1945 about seventy people in England and Wales have died from tetanus, the highest death rate being in boys aged 5 to 14 years, and the morbidity rate is at least twice this figure. In this series the proportion of patients under 20 years of age who had previously been given active protection was only 0·93 per cent.

An advantage of tetanus toxoid over anti-tetanus serum is that tetanus toxoid provides long-lasting protection, whereas anti-tetanus serum gives adequate protection for approximately 3 weeks only. Subsequent doses are broken down even more rapidly so that protection is transient. If a patient has received anti-tetanus serum on a previous occasion it is wise to repeat the dose at 7 to 10 days. Boyd (1946) and other authorities consider passive immunity to be less effective than the active immunity offered by tetanus toxoid administration.

Although tetanus toxoid is the treatment of choice for a patient previously immunized, it has no place in the prevention of tetanus in the acute injury in a non-immunized person. Here anti-tetanus serum must be used. The importance of an adequate dose of anti-tetanus serum was recognized in the First World War when cases of tetanus occurred in the 2nd and 3rd weeks after the injection of 500 units anti-tetanus serum. 3,000 units is the standard protective dose and many consider that 10,000 units should be given if the injury is more than 24 hours old.

(2) Anti-tetanus Serum Reactions

Local reactions occurred in 8·3 per cent. of patients given anti-tetanus serum. It is curious that the incidence of these reactions was twice as high in females as in males. Moynihan (1955) recorded an incidence of 2·7 per cent.

The incidence of general reactions in this series of anti-tetanus serum injections was 1 per cent. Newell and McVea (1940) recorded a reaction of some kind in 11·8 per cent. and serum sickness in 4·4 per cent. of 500 cases. Mishkin (1949) and Fischer (1951) estimated the incidence of general reactions at approximately 15 per cent., Moynihan at 2·5 per cent.

The vast majority of local reactions were not followed by serious reactions though it was the practice to give an adequate dose of antihistamine tablets for 3 days to all patients who had immediate or returned with delayed local reactions. It may be that this suppressed some general reactions, and caused the low incidence of 1 per cent. as compared with the much higher incidence recorded by other investigators. 5·8 per cent. of patients with local reactions developed general reactions but only 0·6 per cent. of those with no local reaction had general reactions. The conclusion that the local reaction is important cannot be escaped.

Laurent and Parish (1952) suggested that anaphylactic reactions occurred in 1 in 50,000 to 200,000 cases. In the present series there were two anaphylactic reactions in 2,744 anti-tetanus serum injections, but these numbers are too small to be statistically significant.

Of the patients who had a general anti-tetanus serum reaction, 48 per cent. noted a local reaction first, at intervals varying from 10 minutes to 6 days, the majority occurring between 8 and 24 hours before the onset of the general reaction. These observations are in opposition to the statements of Laurent and Parish (1952), who described a method of test dosing for serum sensitivity consisting of a preliminary subcutaneous injection of 0·1 ml. anti-tetanus serum, stating that "the object of the trial dose is to determine any predisposition to a general reaction and not to detect any local reaction, the latter having no practical significance". This point was also emphasized by Moynihan (1956), who described "preliminary subcutaneous injections of small doses, which are not given with the purpose of observing a local reaction of any kind". The above results indicate that the local reaction is important, and that due cognizance should be taken of it. It is impossible to assess the full part played by the exhibition of antihistamines in this series, but the possibility that these suppressed more serious reactions should be kept in mind.

Conclusions

The immunity status to tetanus of 3,455 patients has been assessed. The only portion of the population with any active basic immunity to tetanus are the ex-servicemen and the majority of these persons require booster injections to maintain their active immunity. It would require an effort on a national scale to maintain the ideal active immunity which the requirements of war conferred upon them. The maximum incidence of death from tetanus is in boys between 5 and 14 years of age; this section of the population is almost entirely devoid of active immunization and a wider policy of tetanus toxoid inoculation is advised.

The age and sex distribution of patients requiring prophylaxis is recorded.

The incidence of sensitivity reactions has been determined. The effect of known predisposing factors is shown. It is observed that little or no effort has been made to provide patients who have had previous serum, asthma, infantile eczema, and even some cases of previous reaction, with an active immunity.

Previous statements regarding the importance of test dose and local reactions to anti-tetanus serum are contested. It is suggested that patients who show local reactions should be warned to return and that treatment with antihistamines should be instituted in an endeavour to prevent the development of a generalized reaction. These patients should be subsequently inoculated with tetanus toxoid.

I should like to thank Mr. J. M. Fitton and Mr. R. Broomhead for permission to publish details of these cases, and Drs. Rossett, Flowers, Hainsworth, Lyons, Lowe, and Yates, and the staff of the Leeds Public Dispensary for their assistance.

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EFFECT ON LOCAL DEATH RATES OF RECENT CHANGES IN THE STATISTICAL TREATMENT OF HOSPITAL DEATHS

BY

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A previous communication (Hewitt, 1957) drew attention to the disturbances in official mortality rates for local areas of England and Wales which had resulted from a change in the statistical treatment of deaths occurring in hospital. There have since been two further changes in the official procedure, and some revaluation is called for.

Successive modifications of the statistical practice have been announced in the explanatory notes to the Statistical Review of England and Wales (Registrar-General, 1954 (Corrigenda), 1957, 1960). In outline these have been as follows:

(*i*) Up to and including 1951, all deaths in hospital were assigned to the area of the deceased's usual residence.

(*ii*) This rule was relaxed for certain institutions in 1952, and in 1953 all deaths occurring in chronic sick, mental, and mental deficiency hospitals were treated as belonging to the area of the hospital.

(*iii*) In 1954, the original system was restored in the case of some chronic sick and mental hospitals which had a high ratio of deaths-plus-discharges to beds.

(*iv*) In 1956, the method of computing Area Comparability Factors was changed, so that, besides adjusting for local variations in the age-sex composition of the population, these factors now also made an allowance for variations in the proportion of locally-registered deaths which were "non-transferable".

(*v*) In 1958, deaths in all chronic sick, mental, and mental deficiency hospitals again became "transferable"—provided that the deceased had been in hospital less than 6 months.

Some consequences of these changes, so far as they affected areas containing a disproportionately large number of chronic and mental beds, have been traced out in the Figure (opposite). The areas here referred to are the 129 listed in the previous paper plus a further 37 identified from more recent data as net importers of chronic or mental patients, a total of 166. In the years up to 1951 a little over 8 per cent. of all deaths in England and Wales used to be assigned to these areas (see the points marked as circles in the Figure). A slight rise in this percentage in 1952 was followed by a large rise to nearly 12 per cent. in 1955, a small fall in 1954 (on account of *iii*, above), and a further fall in 1958 (on account of *v*).* The average Area Comparability Factor in these areas was close to 0·9 in all the years up to 1955, was lowered to about 0·7 in 1956 (on account of *iv*, above), and was raised again by a few points in 1958–9. The adjusted local mortality rates for these areas necessarily responded to changes both in the numbers of non-transferable deaths and in the Area Comparability Factors (see continuous heavy line in

* The *net* reduction was rather small, because some areas which had, under the 1954 dispensation, been exempted from the new rules, retained far more imported deaths in 1958 than in 1957.

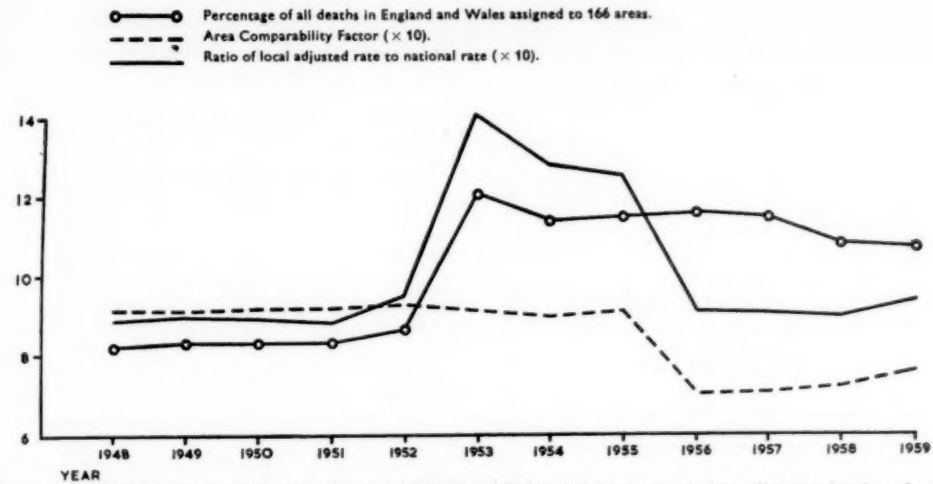

FIGURE.—Trend of certain mortality statistics in 166 areas of England and Wales which import chronic sick and/or mental patients, for the years 1948–59

the Figure). From a level fully 10 per cent. below the national mortality standard in years up to 1951, the average "adjusted" death rate rose to nearly 40 per cent. above the national standard in 1953, fell back to about 25 per cent. above the standard in 1954–5, and then reverted to a near-normal level from 1956 onwards. If we compare the most recent available year (1959) with the last fully normal year (1950—excluding 1951 because of its influenza epidemic), we find that 104 of these areas show a reported increase, relative to the national rate, in "adjusted" mortality, 56 a decrease, and six no change. The disproportion between the numbers of increases and decreases may reflect some upward bias in the rates as now computed for importing areas, but this is certainly small, since the average change is only +4 per cent.

Unfortunately, it does *not* follow that the mortality rates, either of these areas or of the much larger number of exporting areas, have recovered their former value. The present method of computing Area Comparability Factors is explicitly designed to

> "spread the deaths and the populations in chronic sick, mental, and mental deficiency hospitals over all areas of the country in proportion to their non-institutional populations" (Registrar General, 1957).

But this is a mistaken objective which, if pursued to its logical conclusion, would eventually make all local death rates equal by definition to the national death rate. While restoring a more reasonable comparison between the aggregate of importing and exporting areas, the present method must also erode much of the true difference between individual areas.

It is, of course, impossible to say how far the official rate for any individual area deviates from its unknown, proper value. One can, however, test how far the established *pattern* of local mortality rates has survived these administrative changes by correlating the rates in successive years with any local indices known to have predictive value. This has been done for the 28 Metropolitan Boroughs comprising the County of London (see Table), which is a severe test of the present system because of the rather low proportion of chronic and mental patients in London who are taken to hospitals in their own borough. Three indices have been used: average number of persons per room at the 1951 Census; percentage of males aged 15–64 belonging to Social Classes IV and V at the same Census; Standardized Mortality Ratio for a period approximately 20 years earlier. Up to 1951 all three indices had correlations of about 0·8 with the current borough mortality ratios. In 1952 there was a small drop and in 1953 a large drop in all three correlations. A partial restoration of the former pattern was achieved in 1956 (presumably because of the revised method of calculating Area Comparability Factors), but no further improvement has yet resulted from the change of rules instituted in 1958. The present level of these correlations therefore

TABLE

CORRELATIONS BETWEEN ADJUSTED DEATH RATES FOR THE 28 METROPOLITAN BOROUGHS AND CERTAIN PREDICTIVE INDICES, EACH YEAR FROM 1948–59

Year	Non-transferable Deaths	Special Adjustment to Area Comparability Factors	Correlation with:		
			Persons per Room, 1951	Per cent. of Males in Social Class IV–V	Standardized Mortality Ratio of Borough, 1930–32
1948	None	Not Needed	0·83	0·84	0·84
1949			0·84	0·85	0·89
1950			0·84	0·74	0·84
1951			0·83	0·77	0·76
1952	A Few	No	0·73	0·55	0·62
1953	All those in Chronic Sick, Mental, and Mental Deficiency Hospitals		0·16	0·15	0·24
1954			0·20	0·11	0·29
1955			0·14	0·05	0·19
1956		Yes	0·41	0·46	0·47
1957			0·50	0·45	0·46
1958	Those during first 6 months in Chronic Sick, Mental, and Mental Deficiency Hospitals		0·13	0·07	0·20
1959			0·43	0·44	0·53

averages only a little over one half of that found in any year up to 1951.

SUMMARY

The more obvious anomalies in the local mortality rates of England and Wales which resulted from changes in official practice during 1952–53 have now been removed. Nevertheless, recent figures may be less trustworthy than those for the years up to 1951, and this is clearly so in the case of areas within London.

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STILLBIRTH IN THE CITY OF BOMBAY

BY

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Stillbirth is to be encountered in every human population and its causes are the same everywhere, although the magnitude of the contribution of specific causes differs in time and place. In countries where the medical and social services available to the expectant mother have recently undergone a rapid development and where records relating to stillbirth have been maintained for many years, it has been observed that as the standard of living has risen the stillbirth rate has fallen, and it is reasonable to assume that in the future the rate will fall in other countries when the standard of living and of medical care has improved.

The stillbirth ratio in the Indian population as a whole cannot be given. In India, as also for example in Egypt, the figures given in the "Demographic Yearbook of the United Nations" for 1957 (Table I) relate to certain selected registration areas only.

TABLE I

RATIO OF STILLBIRTHS TO LIVE BIRTHS PER 1,000 IN SELECTED COUNTRIES*

Country	Ratio	Year
Ceylon	47·0	1957
Burma	40·0	1955
Chile	32·3	1954
Scotland	24·4	1956
England and Wales	23·5	1956
Austria	18·0	1956
Denmark	17·8	1956
Holland	17·2	1956
France	17·2	1956
Sweden	16·4	1956
Mexico	15·7	1955
Switzerland	13·7	1956
U.S.A.	13·5	1955
Pakistan	13·2	1951
India	8·6	1954
Egypt	6·0	1954

* Demographic Yearbook of the United Nations for the year 1957 Ninth issue).

Though the ratio quoted for India in Table I is certainly very wide of the mark, the decrease in successive years suggests that the ratio of stillbirths to live births is gradually falling (Table II).

TABLE II

RATIO OF STILLBIRTHS TO LIVE BIRTHS PER 1,000 IN INDIA, IN 1948–54*

Year	Ratio
1948	14·4
1949	15·4
1950	13·1
1951	12·6
1952	12·4
1953	11·2
1954	8·6

* Demographic Yearbook of the United Nations for the year 1957 (Ninth issue).

An indication of the trends in the stillbirth rate in India as a whole and of the factors influencing changes therein has been sought in the records for the year 1957 in the Health Department of the Bombay Municipal Corporation. The birth registers give the number of live births as 84,910 and that of stillbirths as 2,378, a stillbirth rate of 27·2 per 1,000 total births (the same definition of stillbirth being accepted in India as in the United Kingdom).

Although it is the practice to register a stillbirth both as a birth and as a death, in many instances only the death was registered. This was particularly so in the case of infants born at home, where the death certificate was required for the purposes of cremation, etc. The number of stillbirths given in the "Annual Report of the Executive Health Officer" for 1957 is 2,861, a stillbirth rate of 32·6 per thousand total births. It is these stillbirths which are registered only as deaths that account for the discrepancy between this figure and that already given (27·2 per thousand), an underestimation of about 5 per thousand.

It was hoped to obtain from the records information regarding maternal age, parity, the district

within the City where the family lived, the place of confinement (home or hospital), the father's occupation and religion, and the sex of the stillborn infant. Many of these particulars were too scanty and uncertain to be of any value; for example, any attempt to construct a social gradient was foiled by the frequent use of such terms as "service" or "business" for the father's occupation. In the end only maternal age, parity, and sex of infant were considered. The actual cause of the stillbirth (for example, disease in the mother, foetal defect, disorder of placenta or cord, etc.) was not stated in the records. Where only the death was registered the maternal age and parity were not available.

Influence of Maternal Age and Parity

Table III shows the stillbirth rate per 1,000 total births in Bombay in 1957 by maternal age. The rate is relatively high in the youngest age group (15 to 19 years), falls during the next decade, but rises again after age 29 and goes up steeply after age 39 (Fig. 1).

Table III

STILLBIRTH RATES PER 1,000 TOTAL BIRTHS, BY MATERNAL AGE, BOMBAY, 1957

Maternal Age (yrs)	Rate
Under 20	30·8
20–	24·4
25–	24·6
30–	31·9
35–	34·5
40+	45·6
All Ages	27·2

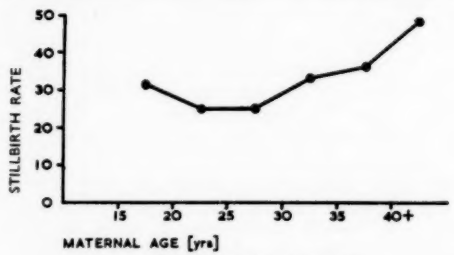

Fig. 1.—Stillbirth rate, by maternal age.

The level for the 30–34 age group is only slightly higher than that for the 15–19 age group, but at 40 years and over it is nearly one and a half times as high. The initial high level can be explained on the grounds of "reproductive immaturity" in the young mother and the secondary rise on the grounds of "reproductive inefficiency" with increasing age.

Table IV shows the stillbirth rate by parity. The rate is relatively high among first births; it then falls sharply but rises again after the fourth confinement and continues to rise with every successive confinement. Although the stillbirth rate starts to rise after the fourth child, it does not exceed the rate for the first until para 7 is reached. After the eighth it rises steeply so that for the tenth it is nearly double the rate for the first. (Fig. 2).

Table IV

STILLBIRTH RATES PER 1,000 TOTAL BIRTHS, BY PARITY, BOMBAY, 1957

Parity	Rate
1	33·4
2	22·0
3	21·8
4	21·6
5	26·5
6	31·7
7	34·3
8	34·7
9	45·5
10+	58·2
All Parities	27·2

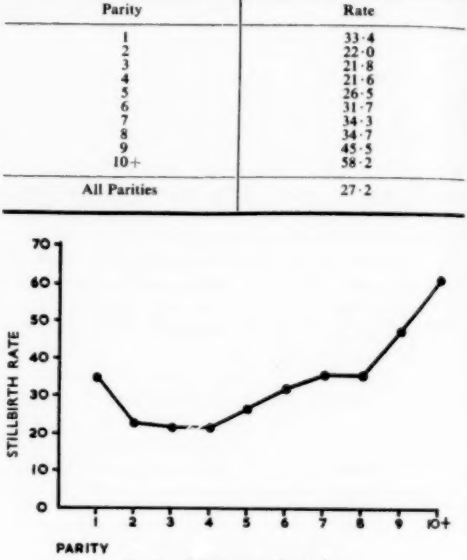

Fig. 2.—Stillbirth rate, by parity.

It has always been found difficult to disentangle the effects of these two influences upon the stillbirth rate, because with every successive confinement the mother's age is inevitably higher. Table V shows the Bombay rates by both age and parity. It can be seen that the effect of parity holds for each of the individual maternal age groups, with high rates in

Table V

STILLBIRTH RATES PER 1,000 TOTAL BIRTHS BY PARITY AND MATERNAL AGE, BOMBAY, 1957

Parity	Maternal Age (yrs)			
	Under 25	25–29	30–34	35+
1	31	41	61	*69*
2, 3, and 4	21	20	26	38
5, 6, and 7	27	29	31	31
8+	*67*	54	45	41

Note: Ratios based on less than twenty stillbirths are shown in italics.

the first birth, lowest rates in the second, third, and fourth, and thereafter a rising rate. On the other hand, the effect of maternal age is not consistent or equally pronounced in each parity group. Up to the fifth birth there is a general rise with age. For the fifth, sixth, and seventh births there is little difference with age and later births show a trend in the opposite direction. These findings are in general agreement with those found in other countries, where the influence of parity has been seen to be rather greater than that of maternal age.

Sex Ratio of Stillbirths

It has been established that conditions conducive to foetal death (with the exception of certain foetal defects) affect male conceptions to a greater extent than female. The sex ratio of live births was 105 in Bombay in 1957, and that of stillbirths 114.

If, therefore, the incidence of stillbirths varies with parity, these variations should be reflected in corresponding variations in the sex ratio of the stillborn. Table VI shows that the sex ratio, which is high for first births, is least for third births and thereafter rises again. The figures for subsequent parities are too small for any firm conclusions to be drawn.

Table VI

SEX RATIO OF STILLBIRTHS, BY PARITY, BOMBAY, 1957

Parity	Sex Ratio
1	1·28
2	1·13
3	1·05
4	1·12
5	1·08
6	1·08
7	1·28
8	1·00
9	1·11
10+	1·42
All Parities	1·14

The sex ratio is analysed by maternal age in Table VII; it is high in the youngest age group, then falls, and then rises steeply in the oldest age group of 40 years and over.

Table VII

SEX RATIO OF STILLBIRTHS, BY MATERNAL AGE, BOMBAY, 1957

Maternal Age (yrs)	Sex Ratio
15–19	1·23
20–24	1·07
25–29	1·14
30–34	1·02
35–39	1·07
40 and Over	1·64
All Ages	1·14

Summary

(1) The Health Department of the Bombay Municipal Corporation recorded 84,910 live and 2,378 stillbirths in 1957, a stillbirth rate of 27·2 per 1,000 total births. If additional data from the death certificates are included, the rate is 32·6 per thousand total births.

(2) The stillbirth rate was high in the maternal age group 15 to 19 years, then fell, then rose again in the 30–34 age group, and continued to rise thereafter.

(3) The stillbirth rate was high for the first parity, then fell, then rose again at the fifth parity, and continued to rise thereafter.

(4) The sex ratio of the stillborn was 114 and of the live born 105. Among the stillborn it was highest for the maternal age groups and parities in which the incidence of stillbirth was highest.

I am deeply grateful to Prof. F. A. E. Crew whose encouragement and constructive criticism stimulated the preparation of this paper. I am indebted to the Executive Health Officer of the Bombay Municipal Corporation for permission to examine records, to Dr. D. V. Parulekar for making these records easily accessible, and to Dr. K. K. Soman for help in abstracting the data. My thanks are due to Dr. V. N. Panse of the Department of Preventive and Social Medicine for his advice and encouragement and to Mr. J. R. Rele for help in analysing the data.

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